PLANT CELL BIOLOGY AND DEVELOPMENT

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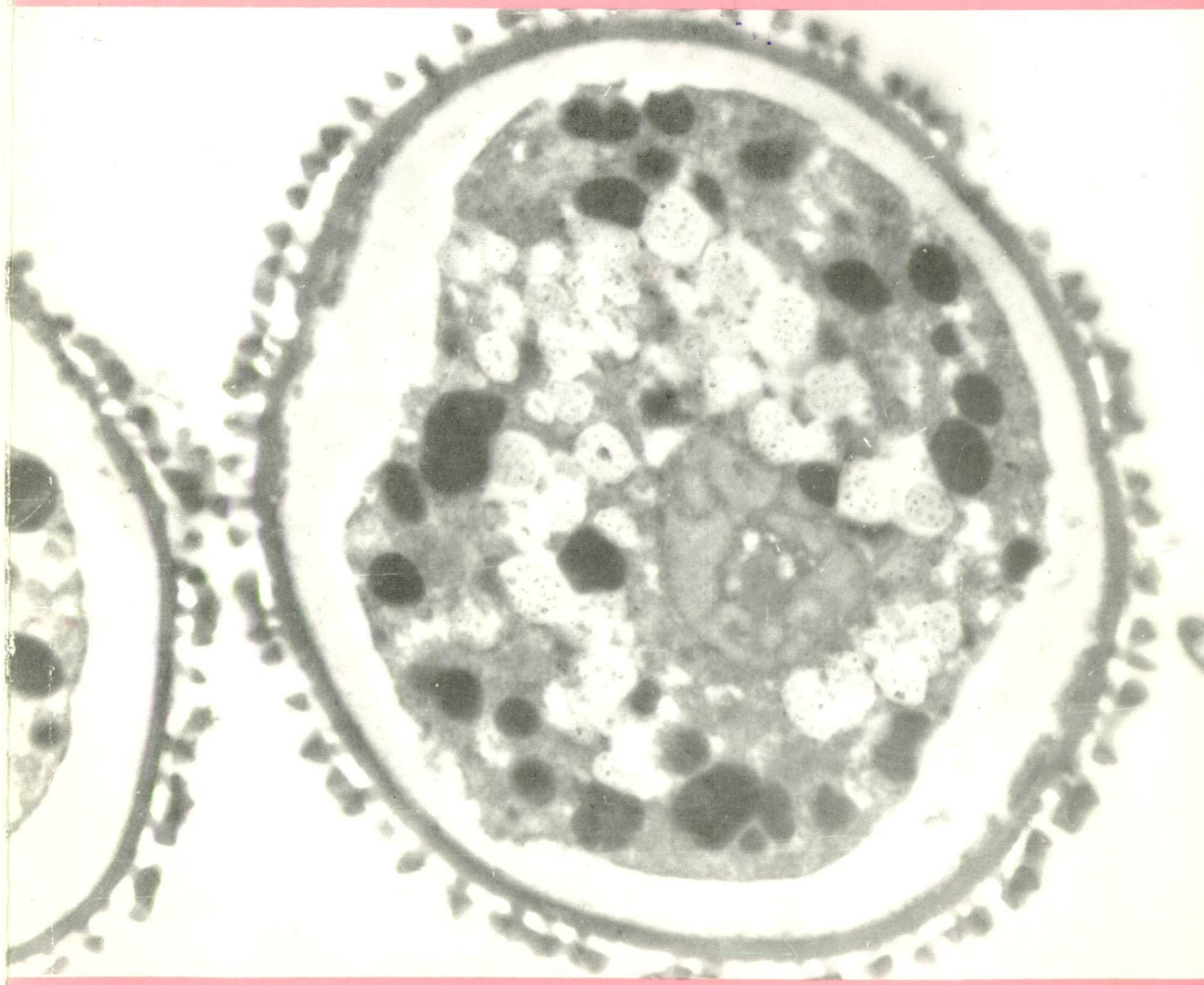

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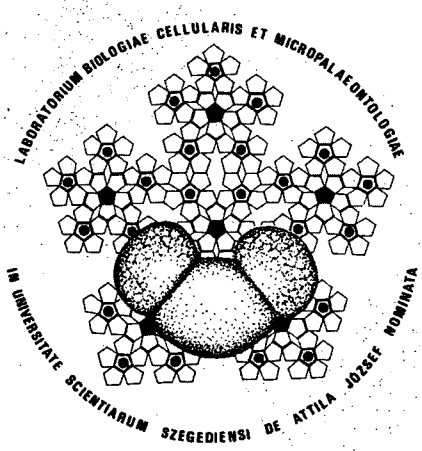

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Contributors

Andrea BORBOLA
Cell Biological and Evolutionary Micropaleontological Laboratory. University Student.

Erika HORVÁTH
Cell Biological and Evolutionary Micropaleontological Laboratory. University Student.

Ágnes KÁROSSY
Cell Biological and Evolutionary Micropaleontological Laboratory. Laboratory Assistant.

Loránd KEDVES
Cell Biological and Evolutionary Micropaleontological Laboratory. University Student.

Miklós KEDVES
Cell Biological and Evolutionary Micropaleontological Laboratory. Honorary Professor.

Éva PAPP-NAGY
Cell Biological and Evolutionary Micropaleontological Laboratory. Laboratory Assistant.

Árpád PÁRDUTZ
Institute of Biophysics, Biological Research Center of the Hungarian Academy of Sciences. Research Councillor, Honorary Professor.

Shyam C. SRIVASTAVA
Birbal Sahni Institute of Palaeobotany, Lucknow, India, Assistant Director and Head of Mesophytic Evolutionary Botany, Convener-Secretary of Birbal-Savitri Sahni Foundation.

Anita TÓTH
Cell Biological and Evolutionary Micropaleontological Laboratory. PhD Scholar, Albert Szent-Györgyi Medical University.

BÁLINT ZÓLYOMI
1908–1997

Preface

This volume is dedicated to the memory of Dr. Bálint ZÓLYOMI member of the Hungarian Academy of Sciences, who died on the 21th September,1997. The Hungarian Botany and Palynology believed that we will should cherish his 90th birthday, but the regrettable event upsetted this hope.

He was one of the most famous researcher of phytogeography but his palynological results are also well appreciated worldwide. Multidisciplinarity characterized his scientifical researches. He was always fond of palynological researches, and he took part as president at the Hungarian paleobotanical/palynological meetings.

Long time ago, when Dr. ZÓLYOMI was the president of the Hungarian Botanical Commission of the Hungarian Academy of Sciences, I was the secretary. During this time I learned a lot from him in every respect, these years were very fruitful for me. We lost a really very great scientist, and a very nice benevolant man.

Accordingly to the tradition of our Laboratory on the 21th August the following persons were awarded with Commemorative Medal of the Laboratory:

Prof. Dr. Eszter NAGY (Hungarian Geological Institute, Budapest), for her outstanding results of the Hungarian Neogene Palynology, and for her self-sacrificing efforts for Palynology and Paleobotany in Hungary.

Prof. Dr. W. EL.-S. EL-SAADAWI (Department of Botany, Faculty of Science, Ain Shams University, Abbasi'ya, Cairo, Egypt), for his contribution to the Paleobotany of Egypt, and for the participation in a joint research program between the Department of Botany of the Ain Shams University and our Laboratory on the macro- and microremnants of the Lower Cretaceous of Sinai.

Prof. Dr. Edward A. STANLEY (Ardmore, PA, U.S.A.). Our scientific career started at the same time and in the same review (Pollen et Spores, Paris). His monograph on the Upper Cretaceous and Paleocene sediments of North America is a basic work on this subject.This was followed by a joint scientific research program (N.S.F. - K.K.I.). LM, TEM and SEM methods were used for *Normapolles* and some selected *Postnormapolles* taxa of North America (U.S.A.), and Europe (France, Hungary).

For the financial support in the presentation of this volume I would like to express my sincerest thanks for the following institutions and persons:

to the Grant OTKA 1/7 T 014692 and T/9 023208,

to the Faculty of Science of the J.A. University,

to the Foundation for the Science of the South Hungarian Plain,

to the Scientific and High-educational Foundation of the Local Government of Szeged,

to K. TANDORI and Gy. TELEGDY, members of the Hungarian Academy of Sciences,

to Dr. I. SZALAY Major and Dr. I. FARKAS Town Councillor of the Local Government of Szeged,

to Prof. Dr. K. VARGA, Dean of the Faculty of Science, J.A. University.

Szeged, 30 December, 1998.

M. KEDVES
Head of the Laboratory

1. RECONSTRUCTION AND AFFILIATION OF MIDDLE TRIASSIC SEEDS FROM INDIA

SHYAM C. SRIVASTAVA

Birbal Sahni Institute of Palaeobotany, Lucknow-226007, India

"Post Award-Commemorative-Lecture"

Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J. A. University, H-6701, P. O. Box 993, Szeged, Hungary

Mister President Commission for Palaeobotany, Hungarian Academy of Science, Head, C.B.E.M. Laboratory, the Fellow Palynologists and learned friends.

Today (21st August, 1997) I have just arrived a long way from India to have this Commemorative "Honour" to be bestowed upon me for the furtherance of Palaeobotany, a multidisciplinary science possessing a synergistic approach. It is not only my presence but the presence of all in itself will mark a moment in spirit of science and the link which SAHNIS established shall be strengthened and strengthened.

On this "Commemorative Day", I congratulate humbly to all of you and more especially; to Professor KEDVES "a jewel" in Palynology for awakening the palaeobotanical platform in Hungary where great palaeobotanist Professor Paul GREGUSS was born.

My lecture embraces the work of nearly three decades of Indian seeds (±2 Hundred Million Years Old) which has marked an advance both from botanical and geological point of view.

After being processed and analysed the bulk of information has yielded much new data resulting which the full significance is brought out.

Abstract

Variety of seed plants occurred in Triassic flora of Nidpur. Epidermal structures together with other morphological features exhibited great amount of diversification among these seeds. Distinction between these seeds is based largely on features of epidermis and particularly on integument characters. Such a restored seed provide meaningful data which increasingly clear the structural identity.

Key words: Seeds, Triassic, India, *Gymnosperm.*

Introduction

Among the variety of macrobotanical elements, detached seeds have been quite conspicuous in Middle Triassic Nidpur shale of Madhya Pradesh, India (SRIVASTAVA and MANIK, 1993). Generally seeds of bigger size have been found in compressed form on the rock surface but when the waste pieces of carbonaceous shale were macerated in bulk, seeds could be isolated in enormous number. The systematic analysis of nearly one thousand seed specimens yielded several genera and species. By pooling information from such seed specimens it could be possible to have a fairly full and accurate picture of reconstruction of taxonomically established seed genera as evidenced by piece of cutinized seed membranes. Their preservation of epidermal details gave an impetus to reconstruct these organs which belonged to different plant groups of *gymnosperm*. The first such reconstruction was attempted by SRIVASTAVA and MANIK (1990) of the taxon *Rostrumaspermum venkatachalae* based upon the epidermal features of various seed membranes. Here ten seed taxa have been reconstructed revealing their differentiation of various integument layers, nucellar and megaspore membranes. The distinct pollen chambers followed by their reduced size or absolute absence has also been clearly demonstrated associated with restoration of exposed or unexposed micropylar opening. These reconstructions (Plate 1.1., figs. 1–10) are fanciful and their size and spatial relationship of various membranes portrayed is largely based on their illustrations. Thus incorporating the entire characters the relationship of these seeds have also been traced out.

Material

Triassic beds are located near Nidpur village in a small fault bounded outcrop in carbonaceous sandy shale of dark to light-grey colours in Gopad river section, western part of Singrauly coalfield, Sidhi District, Madhya Pradesh (Central India). Being in faulted zone "Nidpur beds" could not be eroded and more or less horizontally placed locked up between the two faults on western most extreme. Fossiliferous beds are capped by lilac coloured shale, clays and pinkish coarse grained sandstone (similar to Parsora Formation) and are faulted contact to the north and south with upper Permian strata. The distinctive flora or *Dicroidium* comprising seeds, fruiting bodies and palynofossils have been recovered trapped between the two faults. Beyond fault Permian sediments are exposed.

Carbonaceous remains were extracted in bulk maceration of rock samples in Hydrofluoric acid and seeds were isolated to study immersed in glycerine and subsequent treatment of acid and alkali, observations were noted and finally seeds were mounted in Canada Balsam.

Results

Reconstruction: *Pteridospermous*-seed

In the reconstructions of seed taxa *Sahnispermum indicum* SRIVASTAVA and MANIK (1993), *Delevoryaspermum nidpurensis* SRIVASTAVA and MANIK 1993, *Nidispermum glabrosum* MANIK 1988, *Cupolaspermum marhwasianum* SRIVASTAVA and MANIK

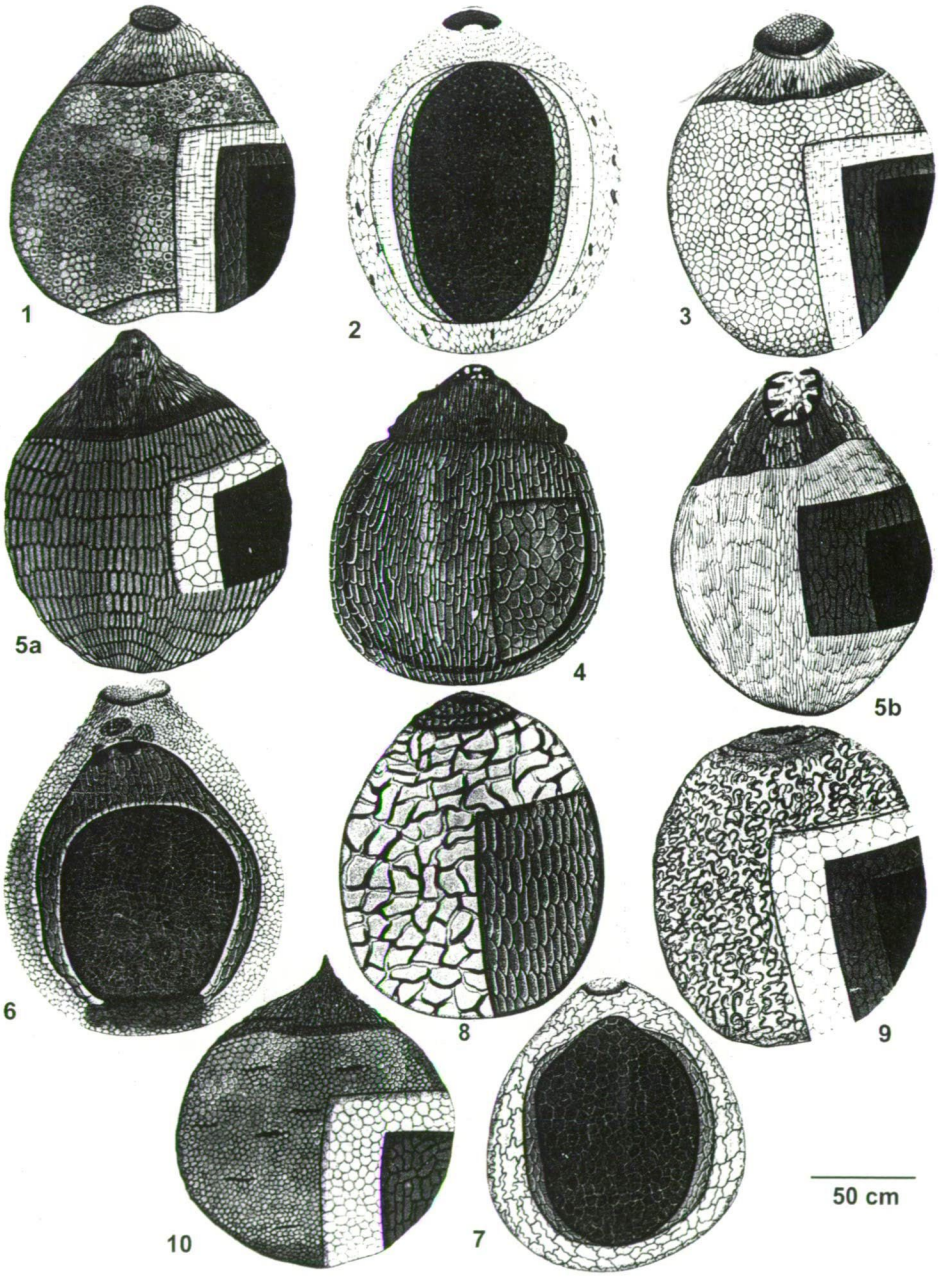

Plate 1.1.

1993 and *Pyriformispermum elongatum* MANIK 1988, differentiation has been based mainly on the features of their cellular characters of integument, distinct pollen chamber and nature of micropylar opening. In *S. indicum* (Plate 1.1., fig. 1) the micropylar opening is asymmetrical and saucer-shaped whereas in *D. nidpurensis* (Plate 1.1., fig. 2) it is somewhat like a bulge appearing to be of bowl-shaped having cutinized rim. But in *N. glabrosum* (Plate 1.1., fig. 3) the micropylar opening looks like lobed structure forming a sort of summit as if for pollen reception. *C. marhwasianum* (Plate 1.1., fig. 4) possessed elliptical-shaped micropylar opening between the two flap-like structures bearing perforated rim all around, a characteristic feature in its own. In *P. elongatum* (Plate 1.1., figs. 5A,B) micropylar opening is depressed and sunken but in some seeds, micropylar hole is inlaid by finger-like projections which might have probably served as a pollen catching device. All these aforesaid seed genera invariably have their pollen chamber well differentiated made up of narrow elongated cells converging towards micropylar end. However, nature of integument is quite variable. The outer integument is generally free from nucellar membrane up to chalazal end. At times the attachment at the base is quite distinct bringing these seeds closer to *pteridosperms*. Further the cells are arranged end to end appearing to be in linear fashion and megaspore membrane is quite conspicuous in suggested reconstructions cut open to depict the various seed membranes.

In *Sahnispermum, Delevoryaspermum, Nidispermum, Cupolaspermum* and *Pyriformispermum*, the outer and inner integuments are frequently free from nucellus up to base, revealing thereby relationship with *Pteridospermales*. Presence of fairly well developed large massive dome-shaped pollen chamber as in *Cupolaspermum* is also indicative of its an alignment with *Pteridospermales*. In *Pyriformispermum* the cutinized finger-like appendages in the inner lining of micropylar hole reflect towards the primitive feature of *pteridosperms* and further provide a supportive evidence for these seeds to be attributed to *Pteridospermales*.

Among these seeds, the reconstructions of the taxa *S. indicum* and *D. nidpurensis* have shown their alliances with that of their parent plant on the grounds of complimentary evidences, for instance the outer integument of *S. indicum* is stomatiferous possessing papillae overhanging stomatal pits. In this characteristic feature, its affiliation is considered to family *Peltaspermaceae*. Also the position of pendant sporangia around the periphery of flattened sporophyll in *Bosea indica* SRIVASTAVA 1975 is built upon similar plan as is marked in case of peltate seeds of *Peltaspermum* HARRIS 1932. It could be inferred on the basis of this particular evidence that there exist an alliance between the leaf *Lepidopteris indica* BOSE and SRIVASTAVA 1972, the microsporangiate

Plate 1.1.

1–10. Triassic seeds from Nidpur.
1. *Sahnispermum indicum* SRIVASTAVA and MANIK, BSIP Nos. 10635, 10637.
2. *Delevoryaspermum nidpurensis* SRIVASTAVA and MANIK, BSIP Nos. 10640, 10641.
3. *Nidispermum glabrosum* MANIK, BSIP Holotype No. 9279.
4. *Cupolaspermum marhwasianum* SRIVASTAVA and MANIK, BSIP No. 10642.
5A,B. *Pyriformispermum elongatum* MANIK, BSIP Holotype No. 9731.
6. *Urceolaspermum gopadensis* SRIVASTAVA and MANIK, BSIP Nos. 10646, 10647.
7. *Tayloriaspermum sinuosum* SRIVASTAVA and MANIK, BSIP Holotye Nos. 10644, 10645.
8. *Konaspermum sidhiensis* SRIVASTAVA and MANIK, BSIP Nos. 19648, 10649, 10651.
9. *Pantiaspermum cristatum* MANIK, BSIP Holotype Nos. 9732, 9733.
10. *Rotundaspermum mucronatum* MANIK, BSIP Holotype No. 9730.

organ *B. indica* and the seed *S. indicum* belonging to the family *Peltaspermaceae*. The seed *S. indicum* is supposedly *peltaspermaceous* because of its close identity in structural features with that of *Lepidopteris* leaf and pollen organ *Bosea*.

Likewise there is a close agreement in between the epidermal features of outer integument of *Delevoryaspermum nidpurensis* and leaf epidermis of *Dicroidium nidpurensis* BOSE and SRIVASTAVA 1971. In their cellular organization smooth nature of surface wall, number of subsidiaries and construction of stomatal apparatus both of leaf and seed integuments apparently are identical. The seed *D. nidpurensus* match so closely with the pollen-organ *Pteruchus nidpurensis* SRIVASTAVA 1974 that it becomes as pointer for the two members to be from a related lineage. Therefore there is greater chance that the two were borne upon possible parent seed plant *Dicroidium nidpurensis*.

Reconstruction: *Cycadean*-seed

Reconstruction in figs. 6 and 7 (Plate 1.1.) are quite distinctive because of having reduced pollen chamber and tenuous outer integument adherent to nucellus getting nucellar apex completely free in micropylar region. The genera *Urceolaspermum gopadensis* SRIVASTAVA and MANIK 1993 and *Tayloriaspermum sinuosum* SRIVASTAVA and MANIK 1993 are the examples revealing such a feature. Besides, in these seeds, micropylar opening is not much projected as we see in *U. gopadensis* where micropyle is subspherical bearing zagged edge while in *T. sinuosum* micropylar opening is unevenly thickened encircled by heavily cutinized rim.

Thus in its overall qualitative aspects, such as having reduced pollen chamber, laterally attached outer integument with nucellus, tenuous outer integument, free nucellar apex from outer integument, thick nucellar membrane (in free part thinner) and well developed highly cutinized megaspore membrane weigh heavily in favour of *cycadean* affinity to this seed taxon. Similarly *T. sinuosum* characterized by outer integument continuing up to micropylar rim and nucellus for a short distance remaining free, depicts its *cycadean* affiliation. In these seeds, extremely reduced pollen chamber delimited from deeply depressed nucellar apex, is an other distinguishing feature for their relationship with *cycads* possessing sinuous anticlinal walls of integument. *T. sinuosum* fully agrees with the leaf of extant *cycads* and shows resemblance with the leaf *Taeniopteris glandulata* SRIVASTAVA 1971, described from same beds of Nidpur.

Reconstruction: *Coniferous*-seed

While evaluating the morphological features, in idealized reconstructions of *Konaspermum sidhiensis* SRIVASTAVA and MANIK 1993, *Pantiaspermum cristatum* MANIK 1988, and *Rotundaspermum mucronatum* MANIK 1988 (Plate 1.1., figs. 8–10), no defined pollen chamber could be marked. The micropylar opening are not very distinctive. In *K. sidhiensis* micropylar hole is blunt and sunken surrounded by thinly cutinized concentric rings but in *P. cristatum* micropylar hole is elliptical, all around ridged or cristate due to excessive proliferation of papillae concealing the opening. Moreover, *R. mucronatum* where micropylar opening is mucronate having small circular hole and short micropylar canal, presents a primitive feature so as for the reception of pollen. However, all these taxa seemingly belong to *Coniferales* largely upon the evidence of nucellar membrane being free over most of the seed bearing outer investment easily detachable and in having pollen chamber not well defined. Additionally in *R. mucro-*

natum its apical micropylar opening associated with short micropylar canal is also indicative of its relationship with *conifers*.

Affiliation

The significant common characters seem to characterize the taxon for its affiliation to the respective plant group. Epidermal features presenting logical grounds have made it possible to determine with good deal of certainty the precise position of a seed taxon in relation to its parent plant. Further the co-existence of seeds with other vegetative fertile plant organs in intimate association revealing identical epidermal details presented convincing evidence for the very close morphological relationship between the compression specimens of other plant organs belonging to the same plant group and has been of utmost importance in tracing the course of their lineage.

Consequently, the seed restorations substantiated by clarity of noteable characters point strongly the representation of various plant groups of *gymnosperm* in the floral assemblage of Nidpur.

Acknowledgements

Thanks are due to Dr. S. R. MANIK and SHRI. P. K. BAJPAI for their all assistance in reconstruction of seeds under the supervision of the author.

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2. UPPER CRETACEOUS POLLEN GRAINS FROM EGYPT III.

M. KEDVES

Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J.A. University, H-6701, P.O. Box 993, Szeged, Hungary

Abstract

The following form-genera are presented in this contribution from the investigated Senonian sediments of Egypt: *Retitricolpites* (VAN DER HAMMEN 1956) VAN DER HAMMEN and WIJMSTRA 1964, *Dettmannaepollenites* n. fgen., *Psilatricolpites* (VAN DER HAMMEN 1956) BURGER 1970, *Cupuliferoidaepollenites* R. POTONIÉ 1960, *Retibrevitricolpites* VAN HOEKEN-KLINKENBERG 1966, *Tricolporoidites* PACLTOVÁ 1971, *Polycolpopollenites*, TREVISAN 1967, *Polycolpites* COUPER 1953, *Retitricolporites* (VAN DER HAMMEN 1956) VAN DER HAMMEN and WIJMSTRA 1964.

New taxa: *Retitricolpites salardae* n. fsp., *R. sowummiae* n. fsp., *R. jardinei* n. fsp., *R. magloirae* n. fsp., *Dettmannaepollenites intrabaculatus* n. fsp., *Psilatricolpites khargaensis* n. fsp., *Retibrevitricolpites aegypticus* n. fsp., *Tricolporoidites pacltovae* n. fsp., *Retitricolporites farafraensis* n. fsp., *R. aegypticus* n. fsp., *R. kirchheimerii* n. fsp., *R. rakosii* n. fsp., *R. elsikii* n. fsp., *R. lachkarii* n. fsp.

Key words: Palynology, fossil, *Angiospermatophyta*, Upper Cretaceous, Egypt.

SUBTURMA: *TRIPTICHES* (~*TRIPTICHA* NAUM. 1937)

Form-genus: *Retitricolpites* (VAN DER HAMMEN 1956) VAN DER HAMMEN and WIJMSTRA 1964

Tricolpate pollen grains with a reticulate surface.

1. *Retitricolpites salardae* n. fsp.
(Plate 2.1., figs. 1-4)

Diagnosis: Amb generally ellipsoidal or secondarily deformed. Surface finely reticulate, the lumen of the reticuli is 0.2-0.4 μm, with the same muri width. The exine is 0.8-1.1 μm on the sides, and sometimes a little thicker (1.5 μm) at the poles. The infratectal layer is thicker than the tectum and the foot layer, T/I/F = 1/1.5/1. The furrows are long but in general do not reach the poles or they are asymmetrical. Around the furrows there are 2.0-2.5 μm wide cavernes.

Polar axis: 24 μm; 20-29 μm.

Holotype: Plate 2.1., figs. 1,2, slide: Farafra-6-2-2-2; cross-table number: 12.2/101.2.

Locus typicus: Farafra, Maestrichtian, Nubia Sandstone.

Stratum typicum: clayey brown coal.

Derivatio nominis: In honour of Dr. M. SALARD CHEBOLDAEFF investigator of the Pre-Quaternary sporomorphs of Africa.

Differential diagnosis: The very finely reticulate surface, and the characteristic cavernes around the furrows separates this fsp. within this genus.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) infrequent, Farafra (11) infrequent, Kharga (1-39) infrequent, Kharga (1-28) infrequent.

2. *Retitricolpites minutus* (BRENNER 1963) n. comb.
(Plate 2.1., figs. 5,6)

Syn.: 1963 *Tricolpites minutus* BRENNER, p. 93, pl. 40, figs. 5,6.
1967 *Cornaceoipollenites minutus* (BRENNER) NORRIS, p. 107, pl. 17, figs. 7-11.
1971 *Cupuliferoipollenites minutus* (BRENNER) SINGH, p. 194, pl. 29, figs. 8,9.
1973 *Tricolpites minutus* (BRENNER) DETTMANN, p. 12,13, pl. 4, figs. 1-4.

Description: Amb ellipsoidal, surface finely reticulate. The lumen of the reticuli is 0.2-0.3 µm, muri width is 0.2 µm generally. The exine is 0.5-0.6 µm thick, the tectum, infratectum and foot layer have the same thickness. The furrows are very narrow (0.2 µm) and do not reach the poles.

Polar axis: 16 µm; 14-20 µm.

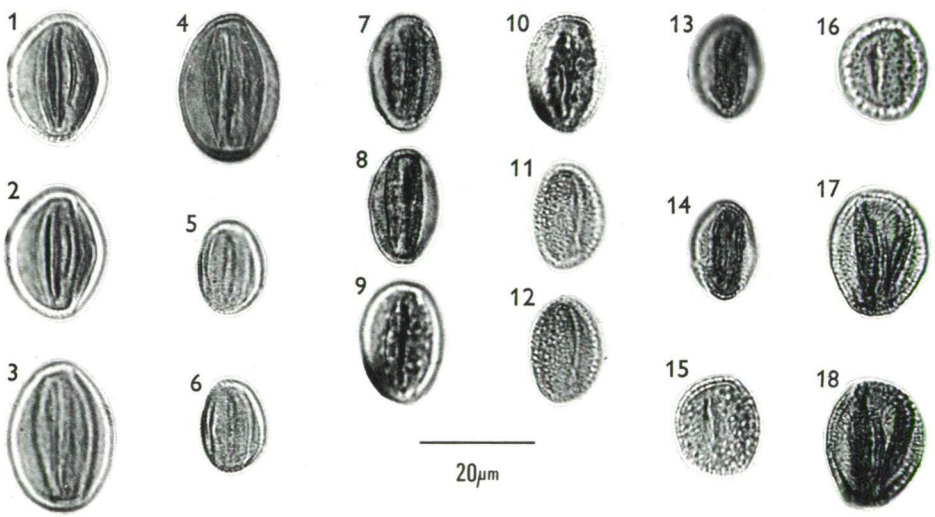

Plate 2.1.

1,2. *Retitricolpites salardae* n. fsp., slide: Farafra-6-2-2-2, cross-table number: 12.2/101.2.
3,4. *Retitricolpites salardae* n. fsp., slide: Farafra-6-2-2-3, cross-table number: 20.8/113.0.
5,6. *Retitricolpites minutus* (BRENNER 1963) n. comb., slide: Farafra-6-2-2-1, cross-table number: 6.6/103.6.
7,8. *Retitricolpites sowunmiae* n. fsp., slide: Abu Minquar-4-3-2, cross-table number: 16.8/116.9.
9,10. *Retitricolpites sowunmiae* n. fsp., slide: Abu Minquar-4-3-5, cross-table number: 14.4/103.1.
11,12. *Retitricolpites prosimilis* NORRIS 1967, slide: Farafra-6-2-2-3, cross-table number: 10.9/113.8.
13,14. *Retitricolpites prosimilis* NORRIS 1967, slide: Kharga-1-39-2, cross-table number: 19.3/120.0.
15,16. *Retitricolpites fragosus* HEDLUND and NORRIS 1968, slide: Farafra-6-2-2-3, cross-table number: 6.8/112.6.
17,18. *Retitricolpites variabilis* (BURGER 1970) n. comb., slide: Abu Minquar-4-3-3, cross-table number: 20.9/106.3.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (11) infrequent, Kharga (1-39) common, Kharga (1-28) dominant, Maestrichtian, fm. indet.: Oweina (1) infrequent.

3. *Retitricolpites sowunmiae* n. fsp.
(Plate 2.1., figs. 7-10)

Diagnosis: Amb ellipsoidal. Surface finely reticulate, the mesh of the reticuli is 0.3-0.5 μm. The exine is 1.5-2.3 μm thick, the three ectexine layers are of equal thickness, T/I/F = 1/1/1. The furrows are narrow (0.3 μm) and generally reach the poles. Around the furrows there are 2-3 μm wide cavernes.

Polar axis: 20 μm; 18-22 μm.

Holotype: Plate 2.1., figs. 7,8, slide: Abu Minquar-4-3-2, cross-table number: 16.8/116.9.

Locus typicus: Abu Minquar, Maestrichtian, Nubia Sandstone.

Stratum typicum: coaly clay.

Derivatio nominis: In honour of Dr. M.A. SOWUNMI investigator of the palynomorphs of Africa.

Differential diagnosis: The thinner exine of the new fsp. separates it from *R. maledictus* GONZÁLEZ GUZMÁN 1967, and *R. promiscuus* LAING 1975.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) frequent, Farafra (6-2-1) infrequent, Kharga (1-39) infrequent, Kharga (1-28) infrequent.

4. *Retitricolpites prosimilis* NORRIS 1967
(Plate 2.1., figs. 11-14)

Description: Amb ellipsoidal. Surface reticulate, the lumen of the reticuli is 0.4-0.6 μm, muri width is about 0.3 μm. The exine is 0.7-0.9 μm thick, the infratectal layer is a little thicker than the tectum and the foot layer, T/I/F = 1/1.5/1. The furrows are long, but do not reach the poles; its width is 0.2 μm. Around the furrows there are cavernes that are 0.3 μm in width.

Polar axis: 18 μm; 17-20 μm.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) infrequent, Kharga (1-39) infrequent.

5. *Retitricolpites fragosus* HEDLUND and NORRIS 1968
(Plate 2.1., figs. 15,16)

Description: Amb circular to ellipsoidal, surface reticulate, the mesh of the reticuli is 0.4-1.8 μm, the muri width is 0.3 μm. The exine is 1.5-2.0 μm thick, the infratectum is a little thicker than the tectum and the foot layer. The furrows are short and do not reach the poles; generally its length is 3/4 of the polar axis. Around the furrows there are small cavernes 0.2-0.3 μm in width.

Polar axis: 18 μm; 16-20 μm.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (11) infrequent.

6. *Retitricolpites variabilis* (BURGER 1970) n. comb.
(Plate 2.1., figs. 17,18)

Syn.: 1970 *Tricolpites variabilis* BURGER, p. 8, pl. I, figs. 1,4.

Description: Amb elliptical, surface reticulate. The lumen of the reticuli is 0.4-0.6 μm, the muri width of 0.3 μm. The exine is 1.0-1.3 μm thick; the infratectal layer is thicker than the tectum and the foot layer T/I/F = 1/1.5/1.8. The furrows are 0.2 μm wide, asymmetrical; around the furrows there are 0.3-0.4 μm wide cavernes.

Polar axis: 22 μm; 20-26 μm.

Occurrences and frequency in the samples investigated from Egypt: Coniacian-Santonian: Abu Rauwash (70-1-7-1) common, Maestrichtian, Nubia Sandstone: Farafra (6-2-1) infrequent. Abu Minquar (4-3) common.

7. *Retitricolpites heteroreticulatus* BOLTENHAGEN 1976
(Plate 2.2., figs. 1-4)

Description: Amb ellipsoidal or secondarily deformed. Surface reticulate, the lumen of the reticuli is 1.0-1.8 μm. Muri width is 0.2-0.4 μm. The exine is 1.5-2.0 μm thick, the infratectum is a little thicker than the tectum and the foot layer, T/I/F = 1/1.5/1. The furrows do not reach the poles: around them there are 4-5 μm wide cavernes.

Polar axis: 32 μm; 26-42 μm.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-1) infrequent, Abu Minquar (4-3) infrequent, Kharga (1-39) infrequent.

8. *Retitricolpites jardinei* n. fsp.
(Plate 2.2., figs. 5-10)

Diagnosis: Amb ellipsoidal. Surface reticulate, the mesh of the reticuli is 0.3-0.5 μm, muri width is 0.2 μm. The exine is 2.5-3.0 μm thick, the infratectum is a little thicker than the tectum and the foot layer; T/I/F = 1/1.5/1. The furrows are asymmetrical, the middle furrow is shorter than the outer one but generally they do not reach the poles. Around the furrows, there are 3-4 μm wide cavernes.

Polar axis: 42 μm; 34-55 μm.

Holotype: Plate 2.2., figs. 5,6, slide: Abu Minquar-4-3-8, cross-table number: 4.8/104.3.

Locus typicus: Abu Minquar, Maestrichtian, Nubia Sandstone.

Stratum typicum: coaly clay.

Derivatio nominis: In honour of Dr. S. JARDINÉ.

Differential diagnosis: The thicker exine separates it from *R. gigantoreticulatus* (JARDINÉ and MAGLOIRE 1965) n. comb. (syn.: 1965 *Tricolpites gigantoreticulatus* JARDINÉ and MAGLOIRE, p. 216, pl. 11, figs. 4,6,7). *Tricolpites tienabaensis* JARDINÉ and MAGLOIRE 1965 sometimes have a reticulate-rugulate or vermiculate surface.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-1) common, Abu Minquar (4-3) infrequent, Kharga (1-39) infrequent, Kharga (1-28) infrequent.

Plate 2.2.

9. *Retitricolpites magloirae* n. fsp.
(Plate 2.2., figs. 11-14)

Diagnosis: Amb ellipsoidal. Surface reticulate, the lumen of the reticuli is 0.5-2.0 µm, muri width is 0.4 µm. The exine is 2.5-3.0 µm thick, the tectum is the thickest between the ectexine layers, T/I/F = 1.5-2/1/1. The furrows are asymmetrical and do not reach the poles.

Polar axis: 53 µm; 48-58 µm.

Holotype: Plate 2.2., figs. 11,12, slide: Abu Minquar-4-3-1, cross-table number: 19.2/114.4.

Locus typicus: Abu Minquar, Maestrichtian, Nubia Sandstone.

Stratum typicum: coaly clay.

Derivatio nominis: In honour of Dr. L. MAGLOIRE investigator of the Senonian sporomorphs of Africa.

Differential diagnosis: The very great size (55-70 µm) of *R. giganteus* (JARDINÉ and MAGLOIRE 1965) n. comb. (syn.: 1965 *Tricolpites giganteus* JARDINÉ and MAGLOIRE, p. 215, pl. 11, figs. 1-3) from the Turonian and the Lower Senonian of Senegal separates it from *R. magloirae* n. fsp.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) infrequent, Abu Minquar (4-3) infrequent, Kharga (1-39) infrequent.

Form-genus: *Dettmannaepollenites* n. fgen.

Form-genus type: *Dettmannaepollenites intrabaculatus* n. fgen. et fsp.
(Plate 2.2., figs. 15-20)

Diagnosis: Tricolpate pollen grains with characteristic free standing infratectal elements in the aperture margin. The exine is tectate imperforate.

Form-genus type: Plate 2.2., figs. 15,16, slide: Abu Minquar-4-3-3, cross-table number: 20.7/115.7.

Locus typicus: Abu Minquar, Maestrichtian, Nubia Sandstone.

Stratum typicum: coaly clay.

Derivatio nominis: In honour of Dr. M.E. DETTMANN, excellent investigator of the Mesozoic sporomorphs.

Plate 2.2.

1,2. *Retitricolpites heteroreticulatus* BOLTENHAGEN 1976, slide: Abu Minquar-4-3-8, cross-table number: 11.2/101.3.
3,4. *Retitricolpites heteroreticulatus* BOLTENHAGEN 1976, slide: Abu Minquar-4-3-4, cross-table number: 11.4/105.0.
5,6. *Retitricolpites jardinei* n. fsp., slide: Abu Minquar-4-3-8, cross-table number: 4.8/104.3.
7,8. *Retitricolpites jardinei* n. fsp., slide: Abu Minquar-4-3-10, cross-table number: 5.3/115.9.
9,10. *Retitricolpites jardinei* n. fsp., slide: Farafra-6-2-2-1, cross-table number: 19.6/102.2.
11,12. *Retitricolpites magloirae* n. fsp., slide: Abu Minquar-4-3-1, cross-table number: 19.2/114.4.
13,14. *Retitricolpites magloirae* n. fsp., slide: Farafra-6-2-1-10, cross-table number: 12.0/102.8.
15,16. *Dettmannaepollenites intrabaculatus* n. fgen. et fsp., slide: Abu Minquar-4-3-3, cross-table number: 20.7/115.7.
17,18. *Dettmannaepollenites intrabaculatus* n. fgen. et fsp., slide: Abu Minquar-4-3-3, cross-table number: 6.8/109.8.
19,20. *Dettmannaepollenites intrabaculatus* n. fgen. et fsp., slide: Abu Minquar-4-3-7, cross-table number: 14.4/116.4.

Differential diagnosis: The imperforate tectum separate well, from *Phimopollenites* DETTMANN 1973.

1. *Dettmannaepollenites intrabaculatus* n. fsp.
(Plate 2.2., figs. 15-20, Text-fig. 2.1.)

Diagnosis: Amb ellipsoidal. Surface scabrate. The exine is 1.3-2.0 μm thick, the infratectum is a little thicker than the tectum and the foot layer. Structure finely intrabaculate. The furrows are 0.2 μm wide in the middle, and 1.5-2.5 μm at their ends and do not reach the poles. The apertural free infratectal elements are very characteristic, 2.0-3.0 μm long, and generally with 1.5 μm basis diameter.

Polar axis: 31 μm; 24-36 μm.

Holotype, locus typicus, stratum typicum see previously.

Derivatio nominis: From the exine structure.

Occurrence and frequency in the samples investigated from Egypt: Lower Campanian: Duwi infrequent; Maestrichtian, Nubia Sandstone: Farafra (6-2-1) infrequent, Abu Minquar (4-3) common, Kharga (1-39) frequent, Kharga (1-28) common.

Form-genus: *Psilatricolporites* (VAN DER HAMMEN 1956) PIERCE 1961

Psilate tricolporate pollen grains (JANSONIUS and HILLS, 2233)

1. *Psilatricolpites pannosus* (DETTMANN and PLAYFORD 1968) BURGER 1970
(Plate 2.3., figs.1-4)

Description: Amb ellipsoidal, surface smooth. The exine is 1.5-2.0 μm thick, the tectum, infratectal layer and the foot layer are equal in thickness, T/I/F = 1/1/1. The fine structure of the infratectal layer is not discernible by optical microscope, probably granular. Furrows narrow and in general reach the poles, around the furrows, there are 1.5-2.0 μm wide, thin and do not so typical cavernes.

Polar axis: 22 μm; 18-23 μm.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-1) common, Farafra (11) infrequent, Abu Minquar (4-3) infrequent, Kharga (1-39) infrequent.

2. *Psilatricolpites khargaensis* n. fsp.
(Plate 2.3., figs. 5,6)

Diagnosis: Amb ellipsoidal, surface psilate. The exine is 1.5-2.2 μm thick, the infratectal layer is the thickest between the ectexine layers. Structure probably granular. The furrows are short, and do not reach the poles. Around the furrows, there are characteristic, 1.5-1.8 μm wide cavernes.

Polar axis: 20 μm; 18-24 μm.

Holotype: Plate 2.3., figs. 5,5, slide: Kharga-1-28-1, cross-table number: 12.7/115.8.

Locus typicus: Kharga, Maestrichtian, Nubia Sandstone.

Stratum typicum: aleurite.

Derivatio nominis: From Kharga.

Differential diagnosis: The shorter furrows and the characteristic cavernes clearly separates this species from *P. pannosus* (DETTMANN and PLAYFORD 1968) BURGER 1970.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Kharga (1-28) common.

Form-genus: *Cupuliferoidaepollenites* R. POTONIÉ 1960

Small psilate tricolpate pollen grains. It should be emphasized, that is many cases it is not easy to distinguish *Psilatricolpites* from *Cupuliferoidaepollenites*. POTTER (1976) published SEM pictures of these pollen grains. The tectum is perforated, based on the SEM data.

1. *Cupuliferoidaepollenites quisqualis* (R. POTONIÉ 1934) R. POTONIÉ 1960, *Fagaceae* v. *Leguminosae*
(Plate 2.3., figs. 7-10)

Description: Tricolpate pollen grains, amb ellipsoidal, surface smooth. The exine is 0.6-0.8 µm thick, the three layers of the ectexine are of equal thickness, T/I/F = 1/1/1. The furrows generally do not reach the poles.

Polar axis: 12 µm; 11-13 µm.

Occurrence and frequency in the samples investigated from Egypt: Coniacian-Santonian: Abu Rauwash (70-1-7-2) infrequent, Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) common, Farafra (11) common, Kharga (1-39) dominant, Kharga (1-28) frequent.

2. *Cupuliferoidaepollenites liblarensis* (THOMSON, in POTONIÉ, THOMSON and THIERGART 1950) R. POTONIÉ 1960, *Fagaceae* v. *Leguminosae*
(Plate 2.3., figs. 11,12)

Description: Amb elongated, ellipsoidal, surface smooth or scabrate. The exine is 0.6-0.8 µm thick, the infratectal layer is a little thicker than the tectum and the foot layer T/I/F = 1/1.5/1. Structure finely intrabaculate. The furrows generally reach the poles.

Polar axis: 17 µm; 16-18 µm.

Occurrence and frequency in the samples investigated from Egypt: Lower Campanian: Duwi common, Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) common, Farafra (11), Kharga (1-39) frequent, Kharga (1-28) common.

Form-genus: *Retibrevitricolpites* VAN HOEKEN-KLINKENBERG 1966

Brevitricolpate, reticulate pollen grains.

1. *Retibrevitricolpites aegypticus* n. fsp.
(Plate 2.3., figs. 13-16)

Diagnosis: Amb circular, surface reticulate or perforate. The lumen is 0.3-0.5 µm in diameter, muri width is 0.3 µm. The exine is 0.5-0.7 µm, the three ectexine layers are of equal thickness, T/I/F = 1/1/1. The fine structure of the infratectal layer is not discernible by optical microscope. The furrows are 4-6 µm long.

Diameter: 19 μm; 17-20 μm.

Holotype: Plate 3.2., figs. 13,14, slide: Abu Minquar-4-3-6, cross-table number: 9.4/106.4.

Locus typicus: Abu Minquar, Maestrichtian, Nubia Sandstone.

Stratum typicum: coaly clay.

Derivatio nominis: From Egypt.

Differential diagnosis: *R. triangulus* VAN HOEKEN-KLINKENBERG 1966 is triangular, and the lumina of the reticulum are 1 μm, *R. bendeensis* JAN DU CHÊNE, ONYIKE and SOWUNMI 1978 is larger (35 μm), and the muri width and the diameter of the lumina of the reticulum measure 1 μm.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Abu Minquar (4-3) infrequent, Kharga (1-28) common, Maestrichtian, fm. indet.: Oweina (1) infrequent.

Form-genus: *Tricolporoidites* PACLTOVÁ 1971

This is an important form-genus, which include the intermediate forms between tricolpate and tricolporate type. It has been demonstrated in several cases, that these characteristic features may occur in one single recent species. However the form varieties of the *angiosperm* pollen grains are not so well elaborated, and for this reason, the form-genera are necessary.

Plate 2.3.

1,2. *Psilatricolpites pannosus* (DETTMANN and PLAYFORD 1968) BURGER 1970, slide: Abu Minquar-4-3-4, cross-table number: 10.1/107.6.
3,4. *Psilatricolpites pannosus* (DETTMANN and PLAYFORD 1968) BURGER 1970, slide: Farafra-6-2-1-4, cross-table number: 20.2/104.5.
5,6. *Psilatricolpites khargaensis* n. fsp., slide: Kharga-1-21-1, cross-table number: 12.7/115.8.
7,8. *Cupuliferoidaepollenites quisqualis* (R. POTONIÉ 1934) R. POTONIÉ 1960, Fagaceae v. Leguminosae, slide: Farafra-6-2-2-4, cross-table number: 9.9/112.7.
9,10. *Cupuliferoidaepollenites quisqualis* (R. POTONIÉ 1934) R. POTONIÉ 1960, Fagaceae v. Leguminosae, slide: Farafra-6-2-2-1, cross-table number: 10.7/102.7.
11,12. *Cupuliferoidaepollenites liblarensis* (THOMSON, in POTONIÉ, THOMSON and THIERGART 1950) R. POTONIÉ 1960, Fagaceae v. Leguminosae, slide: Farafra-6-2-2-2, cross-table number: 12.8/108.5.
13,14. *Retibrevitricolpites aegypticus* n. fsp., slide: Abu Minquar-4-3-6, cross-table number: 9.4/106.4.
15,16. *Retibrevitricolpites aegypticus* n. fsp., slide: Abu Minquar-4-3-10, cross-table number: 10.6/110.3.
17,18. *Tricolporoidites pacltovae* n. fsp., slide: Abu Minquar-4-3-1, cross-table number: 4.1/105.3.
19,20. *Tricolporoidites pacltovae* n. fsp., slide: Abu Minquar-4-3-6, cross-table number: 9.2/118.3.
21,22. *Polycolpopollenites* fsp., slide: Farafra-6-2-1-9, cross-table number: 3.4/101.6.
23,24. *Polycolpites* fsp., slide: Kharga-1-39, cross-table number: 17.1/109.2.
25,26. *Retitricolporites ecommoyensis* LAING 1975, slide: Farafra-6-2-2-1, cross-table number: 8.3/105.6.
27,28. *Retitricolporites ecommoyensis* LAING 1975, slide: Farafra-6-2-1-1, cross-table number: 20.8/108.8.
29,30. *Retitricolporites farafraensis* n. fsp., slide: Farafra-6-2-2-1, cross-table number: 5.1/106.9.
31,32. *Retitricolporites farafraensis* n. fsp., slide: Farafra-6-2-2-5, cross-table number: 11.1/112.8.
33,34. *Retitricolporites aegypticus* n. fsp., slide: Farafra-6-2-2-4, cross-table number: 12.1/117.1.
35,36. *Retitricolporites aegypticus* n. fsp., slide: Farafra-6-2-2-7, cross-table number: 5.4/108.2.
37,38. *Retitricolporites kirchheimerii* n. fsp., slide: Farafra-6-2-2-1, cross-table number: 6.8/117.9.
39,40. *Retitricolporites rakosii* n. fsp., slide: Abu Minquar-4-3-1, cross-table number: 14.4/118.1.
41,42. *Retitricolporites rakosii* n. fsp., slide: Farafra-6-2-2-1, cross-table number: 17.3/100.2.
43,44. *Retitricolporites elsikii* n. fsp., slide: Abu Minquar-4-3-2, cross-table number: 4.5/115.3.
45,46. *Retitricolporites lachkarii* n. fsp., slide: Abu Minquar-4-3-3, cross-table number: 6.2/106.1.
47,48. *Retitricolporites lachkarii* n. fsp., slide: Farafra-6-2-2-3, cross-table number: 8.3/108.2.
49,50. *Retitricolporites ogowensis* BOLTENHAGEN 1976, slide: Abu Minquar-4-3-3, cross-table number: 18.4/112.4.


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Plate 2.3.

1. *Tricolporoidites pacltovae* n. fsp.
(Plate 2.3., figs. 17-20)

Diagnosis: Isodiametric pollen grains, surface finely reticulate, the lumen of the reticuli and the muri width is in general 0.2 μm. The exine is 1.0-1.3 μm thick, the infratectal layer is thicker than the tectum and the foot layer, T/I/F = 1/2/1. The furrows are narow with "Cyrillaceae morphology". These are 2.0-2.3 μm wide, with the characteristic cavernes around the furrows. No characteristic endoapertures but there are sometimes thinnings on the inner exine layer.

Polar axis: 18 μm; 17-22 μm.

Holotype: Plate 3.2., figs. 17,18, slide: Abu Minquar-4-3-1, cross-table number: 4.1/105.3.

Locus typicus: Abu Minquar, Maestrichtian, Nubia Sandstone.

Stratum typicum: coaly clay.

Derivatio nominis: In honour of Dr. B. PACLTOVÁ.

Differential diagnosis: The form-species *T. bohemicus* PACLTOVÁ 1971, *T. minutus* PACLTOVÁ 1971, and *T. subtilis* PACLTOVÁ 1971 are smaller. The sculpture of *T. minimus* is similar to our new species, but the exine is very thick.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Abu Minquar (4-3) infrequent, Kharga (1-39) common.

SUBTURMA: *POLYPTICHES* (~ *POLYPTICHA* NAUMOVA 1937) R. POTONIÉ 1960

Form-genus: *Polycolpopollenites* TREVISAN 1967

The number of the colpi of these pollen grains are greater that three.

1. *Polycolpopollenites* fsp.
(Plate 2.3., figs. 21,22)

Description: Amb elliptical, surface smooth or scabrate. The exine is 0.6-0.8 μm thick, the infratectal layer is a little thicker than the tectum and the foot layer; T/I/F = 1/1.5/1. The number of the furrows are 4, in general, and do not reach the poles.

Polar axis: 31 μm; 30-33 μm.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-1) infrequent.

Form-genus: *Polycolpites* COUPER 1953

The number of the colpi are greater than six. This characteristic feature separates this genus from the previous form-genus.

1. *Polycolpites* fsp.
(Plate 2.3., figs. 23,24)

Description: Amb ellipsoidal. Surface finely reticulate to foveolate, the mesh of the reticuli is 0.15-0.25 μm, muri width is 0.2 μm. The exine is 2.0-2.5 μm thick, sometimes thicker at the poles (3.0-3.5 μm): its structure is not discernible by optical microscope.

The infratectal layer is irregular and the thickest between the ectexine layers, T/I/F = 1/2/1. The number of the furrows is 10, in general, and do not reach the poles.

Polar axis: 45 μm.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Kharga (1-39) infrequent.

SUBTURMA: *PTYCHOTRIPORITES* (~ *PTYCHOTRIPORINA* NAUMOVA 1937) R. POTONIÉ 1960

Form-genus: *Retitricolporites* (VAN DER HAMMEN 1956) VAN DER HAMMEN and WIJMSTRA 1964

Tricolporate, reticulate pollen grains.

1. *Retitricolporites ecommoyensis* LAING 1975
(Plate 2.3., figs. 25-28)

Description: Amb ellipsoidal. Surface very finely reticulate, the mesh of the reticuli is 0.2 μm, the muri are 0.15 μm in width. The exine is 0.6-0.8 μm thick, the infratectal layer is a little thicker than the tectum and the foot layer. The furrows are long but do not reach the poles. Around the furrows there are 1 μm wide cavernes. The endopores are sometimes not clearly discernible, sometimes these pollen grains are poroidate, but generally the size of the endoaperture is 1.5-2.0 μm.

Polar axis: 14 μm; 12-16 μm.

Occurrence and frequency in the samples investigated from Egypt: Maestrictian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) infrequent, Maestrichtian, fm. indet.: Oweina (3) infrequent.

2. *Retitricolporites farafraensis* n. fsp.
(Plate 2.3., figs. 29-32)

Diagnosis: Amb ellipsoidal. Surface very finely reticulate, the mesh of the reticuli and the muri width is 0.15-0.25 μm. The exine is 0.5-0.7 μm thick, the tectum, infratectum and the foot layer are of equal thickness, T/I/F = 1/1/1. The furrows do not reach the poles and converge in the direction of the polar area. Around the furrows there are cavernes with 1.5 μm maximal width near the endopores; the cavernes become narrower. The endopores are tiny and circular, 0.3-0.5 μm in diameter.

Polar axis: 19 μm; 16-20 μm.

Holotype: Plate 2.3., figs. 29,30, slide: Farafra-6-2-1, cross-table number: 5.1/106.9.

Locus typicus: Farafra, Maestrichtian, Nubia Sandstone.

Stratum typicum: clayey brown coal.

Derivatio nominis: From Farafra.

Differential diagnosis: *R. medius* GONZÁLEZ GUZMÁN 1967 is larger (21-35 μm) and its polar area is small.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Abu Minquar (4-3) infrequent.

3. *Retitricolporites aegypticus* n. fsp.
(Plate 2.3., figs. 33-36)

Diagnosis: Amb ellipsoidal, sometimes circular. Surface finely reticulate, the lumen of the reticuli is 0.3-0.4 μm, the muri width is 0.2-0.3 μm. The exine is 1.6-2.2 μm thick, the infratectum is a little thicker than the tectum and the foot layer, T/I/F = 1/1.5-2/1. The furrows are convergent in the polar direction and in general reach them. The width of the caverne is 1.5-1.8 μm and it is not present in the endoapertural region. Endoaperture narrow and meridionally elongated, 0.8-2.5 μm in size.

Polar axis: 18 μm; 13-19 μm.

Holotype: Plate 2.3., figs. 33,34, slide: Farafra-6-2-2-4, cross-table number: 12.1/117.1.

Locus typicus: Farafra, Maestrichtian, Nubia Sandstone.

Stratum typicum: clayey brown coal.

Derivatio nominis: From Egypt.

Differential diagnosis: The thicker exine, and the convergent furrows in the polar direction separates this species from *R. farafraensis* n. fsp.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) common, Maestrichtian, fm. indet.: Oweina (3) infrequent.

4. *Retitricolporites kirchheimerii* n. fsp.
(Plate 2.3., figs.37,38)

Diagnosis: Amb circular to elliptical. Surface reticulate, the lumen of the reticuli is 0.3-0.4 μm, the muri width is 0.2-0.3 μm. The exine is 0.6-0.8 μm thick, the three ectexine layers are equal in thickness, T/I/F = 1/1/1. The furrows are parallel with the ambitus and generally reach the poles. The cavernes are 2.0-2.5 μm in width, the endoapertures are narrow, meridionally oriented, short furrows; 0.5 x 4-5 μm.

Polar axis: 17 μm; 16-19 μm.

Holotype: Plate 2.3., figs. 37,38, slide: Farafra-6-2-2-1, cross-table number: 6.8/117.9.

Locus typicus: Farafra, Maestrichtian, Nubia Sandstone.

Stratum typicum: clayey brown coal.

Derivatio nominis: In honour of Prof. Dr. F. KIRCHHEIMER pioneer of African Senonian palynology.

Differential diagnosis: The endoapertures, the meridionally oriented furrows separates this species from *R. aegypticus* n. fsp. The lumina of *R. craceus* GONZÁLEZ GUZMÁN 1967 are 1 μm, which is larger than those of the new fsp.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Abu Minquar (4-3) infrequent, Kharga (1-28) common.

5. *Retitricolporites rakosii* n. fsp.
(Plate 2.3., figs. 39-42)

Diagnosis: Amb ellipsoidal, surface reticulate, the mesh of the reticuli is 0.6-1.1 μm, the muri width is 1.0 μm. The exine is 1.5-2.0 μm thick, the tectum, infratectum, and the foot layer are equally thick. The furrows generally reach the poles, the cavernes are 1.5-2.0 μm in width. Endopores meridionally oriented short colpi: 0.3 x 2.0-3.0 μm.

Polar axis: 21 μm; 20-23 μm.

Holotype: Plate 2.3., figs. 39,40, slide: Abu Minquar-4-3-1, cross-table number: 14.4/118.1.

Locus typicus: Abu Minquar, Maestrichtian, Nubia Sandstone.

Stratum typicum: coaly clay.

Derivatio nominis: In honour of Dr. L. RÁKOSI excellent investigator of the Lower Tertiary palynomorphs.

Differential diagnosis: *R. potoniei* KEDVES 1978 is larger (28-34 μm) and the endoapertures are meridionally oriented furrows. *R. finitus* GONZÁLEZ GUZMÁN 1967 is also larger: 27-35 μm.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) common, Abu Minquar (4-3) infrequent, Kharga (1-34) infrequent, Kharga (1-28) infrequent.

6. *Retitricolporites elsikii* n. fsp.
(Plate 2.3., figs. 43, 44)

Diagnosis: Amb ellipsoidal, but a little larger meridionally. Surface finely reticulate, the lumina of the reticulum measure about 0.3-0.5 μm, the muri width is 0.2 μm. The exine is 0.7-0.9 μm thick, the tectum, infratectum and the foot layer are of equal thickness. Structure finely intrabaculate. The furrows are narrow and long but generally do not reach the poles. The cavernes are meridionally 3.0-3.5 μm wide, and become narrower in the polar direction. The endoapertural area is prominent. Endopore circular, with a diameter of 3-4 μm.

Polar axis: 23 μm; 20-25 μm.

Holotype: Plate 2.3., figs. 43,44, slide: Abu Minquar-4-3-2, cross-table number: 4.5/115.3.

Locus typicus: Abu Minquar, Maestrichtian, Nubia Sandstone.

Stratum typicum: coaly clay.

Derivatio nominis: In honour of Dr. W.C. ELSIK, excellent investigator of the Lower Tertiary sporomorphs.

Differential diagnosis: *R. andreanszkyi* KEDVES 1978 is larger (26-32 μm) and the lumina of the reticulum are 0.5-1.0 μm these characteristic features separate it from the new form-species.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-1) infrequent, Abu Minquar (4-3) infrequent, Kharga (1-39) infrequent.

7. *Retitricolporites lachkarii* n. fsp.
(Plate 2.3., figs. 45-48)

Diagnosis: Amb ellipsoidal. Surface reticulate. The lumina of the reticulum measure about 0.6-1.4 μm in diameter. The muri are about 0.3 μm. The exine is 0.8-2.8 μm thick, the tectum, infratectum and the foot layer are equal. Structure intrabaculate. The furrows are long, but generally do not reach the poles, and bend in the direction of the poles. The cavernes are 2-3 μm wide in the endoapertural region, and are about 1.5 μm wide at their ends. The endopori are ellipsoidal, 1.5-2.0 x 3.0 μm in size.

Polar axis: 27 μm; 21-32 μm.

Holotype: Plate 2.3., figs. 45,46, slide: Abu Minquar-4-3-3, cross-table number: 6.2/106.1.

Locus typicus: Abu Minquar, Maestrichtian, Nubia Sandstone.

Stratum typicum: coaly clay.

Derivatio nominis: In honour of Dr. G. LACHKAR.

Differential diagnosis: The ellipsoidal endopore, and the thicker exine separates this taxon from R. elsikii n. fsp.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) infrequent, Abu Minquar (4-3) common, Kharga (1-39) common, Kharga (1-28) infrequent.

8. *Retitricolporites ogowensis* BOLTENHAGEN 1976
(Plate 2.3., figs. 49,50)

Description: Amb ellipsoidal. Surface reticulate, the lumina of the reticulum measure from 1.0-1.5 μm in size and the muri width is 0.5 μm. The exine is 2.0-2.5 μm thick, the infratectal layer is a little thicker than the tectum and the foot layer, T/I/F = 1/1.5/1. The furrows are asymmetrical, and generally do not reach the poles. Cavernes are 4-5 μm wide in the endoapertural region, and about 2.0 μm at their ends. Endopore is large and circular, 4.0-5.0 μm in diameter.

Polar axis: 42 μm; 38-50 μm.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Abu Minquar (4-3) infrequent.

Remark. - The slides are deposited in the Cell Biological and Evolutionary Micropaleontological Laboratory of the Dept. of Botany of the J.A. University, Szeged, Hungary.

To be continued

Acknowledgements

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3. ÉTUDES PALYNOLOGIQUES DES COUCHES DU TERTIAIRE INFÉRIEUR DE LA RÉGION PARISIENNE. X.

M. KEDVES

Laboratoire de Biologie cellulaire et de Micropaléontologie évolutive de l'Institut botanique de l'Université J. A. de Szeged, H-6701, B.P. 993, Hongrie

Sommaire

Cette partie est la dernière des études taxonomiques des échantillons des localités types du Bassin de Paris. La partie terminale des *Longiaxes*, ensuite les *Tétrades* et *Polyades* sont présentés dans cette étude avec les genres de forme suivante: *Verrutricolporites, Striatricolporites, Ilexpollenites, Foveotricolporites, Retitricolporites, Caprifoliacidites, Nagyipollis, Oligopollis, Tetracolporopollenites, Polycolporopollenites, Ericipites, Acaciapollenites, Poropolyadopollenites.*

Mots clés: Palynologie, Tertiaire inférieur, Région Parisienne, France.

Note. - Les lames ont été déposées dans le Laboratoire de Palynologie E.P.H.E., Paris, France.

Fgen.: *Verrutricolporites* VAN DER HAMMEN et WIJMSTRA 1964
Syn.: 1969 SAH et KAR, *Verrucolporites* n.g., p. 132.

1. *Verrutricolporites ovalis* (R. POTONIÉ 1934) KEDVES 1978
(Planche 3.1., fig. 1-6)

Présence: Sparnacien moyen: Boulogne-la-Grasse 21/6-18; Sparnacien supérieur: Nointel.

Appartenance botanique probable: *Fabaceae.*

Fgen.: *Striatricolporites* (VAN DER HAMMEN 1956) LEYDELMEYER 1966

1. *Striatricolporites striatus* (SIMONCSICS 1964) KEDVES 1978
(Planche 3.1., fig. 7-10)

Présence: Sparnacien moyen: Sinceny 21/6-12; Sparnacien supérieur: Neuilly-46, Cuisien supérieur: Cuise-2.

Homonym: *S. striatus* (NORTON 1969) n. comb., basionym: 1969. - NORTON, in NORTON et HALL, *Tricolporopollenites striatus* NORTON sp. nov., p. 51, pl. 7, 21. Pour cette espèce nous proposons le *Striatricolporites nortonii* nov. nom.

2. *Striatricolporites pseudoaceroides* (GRUAS-CAVAGNETTO 1968) KEDVES 1978
(Planche 3.1., fig. 11,12)

Présence: Thanétien, zone II: Anizy-le-Château.

Appartenance botanique probable: cf. *Aceraceae.*

Homonym: *S. pseudoaceroides* (KRUTZSCH et VANHOORNE 1977) n. comb., basionym: 1977. - KRUTZSCH et VANHOORNE, *Tricolporopollenites pseudoaceroides* n. fsp., p. 71,72, pl. 30, 1-5. Pour cette espèce nous proposons le *Striatricolporites vanhoornii* nov. nom.

3. *Striatricolporites striatopunctatus* (KRUTZSCH et VANHOORNE 1977) n. comb.
(Planche 3.1., fig.13,14)

Syn.: 1977. - KRUTZSCH et VANHOORNE, *Tricolporopollenites striatopunctatus* n. fsp., p. 78, pl. 43, 22-28.

Présence: Cuisien supérieur: Fosses I-III.

4. *Striatricolporites solé de portai* (KEDVES 1965) KEDVES 1978
(Planche 3.1., fig. 15-18)

Présence: Thanétien, zone II: Anizy-le-Château; Sparnacien inférieur: Arpenty B1-118; Sparnacien moyen: Chavot, Sinceny 21/6-12; Sparnacien supérieur : Guitrancourt B1-32, Sinceny 21/6-7,8; Sparnacien, Facies Argiles des Flandres: Watten B1-6; Cuisien supérieur: Cuise-2.

Appartenance botanique probable: *Fabaceae.*

Fgen.: *Ilexpollenites* (THIERGART 1937) R. POTONIÉ 1960

1a. *Ilexpollenites margaritatus* (R. POTONIÉ 1931a) THIERGART 1937 f. *medius* PFLUG et THOMSON 1953
(Planche 3.1., fig. 19,20)

Présence: Sparnacien moyen: Chavot; Sparnacien supérieur: Neuilly-46, Neuilly-37; Lutétien supérieur: Paris, Austerlitz.

Appartenance botanique probable. *Aquifoliaceae, Ilex.*

1b. *Ilexpollenites margaritatus* (R. POTONIÉ 1931a) THIERGART 1937 f. *minor* PFLUG et THOMSON 1953
(Planche 3.1., fig. 21,22)

Présence: Sparnacien supérieur: Neuilly-46, Neuilly-37; Sparnacien, Facies Argiles des Flandres: Watten B1-6.

Appartenance botanique probable: *Aquifoliaceae, Ilex.*

2. *Ilexpollenites nakomani* KEDVES 1978
(Planche 3.1., fig. 23,24)

Présence: Thanétien, zone II: Anizy-le-Château; Sparnacien moyen: Boulogne-la-Grasse 21/6-18.

Appartenance botanique probable: cf. *Aquifoliaceae.*

3. *Ilexpollenites erdtmani* KEDVES 1978
(Planche 3.1., fig. 25,26)

Présence: Sparnacien supérieur: Nointel, Neuilly-46, Neuilly-37.

Appartenance botanique probable: *Aquifoliaceae.*

Fgen.: *Foveotricolporites* PIERCE 1961

1. *Foveotricolporites snopkovae* KEDVES 1978
(Planche 3.1., 27,28)

Présence: Lutétien supérieur: Paris, Austerlitz.

Appartenance botanique probable: *Euphorbiaceae.*

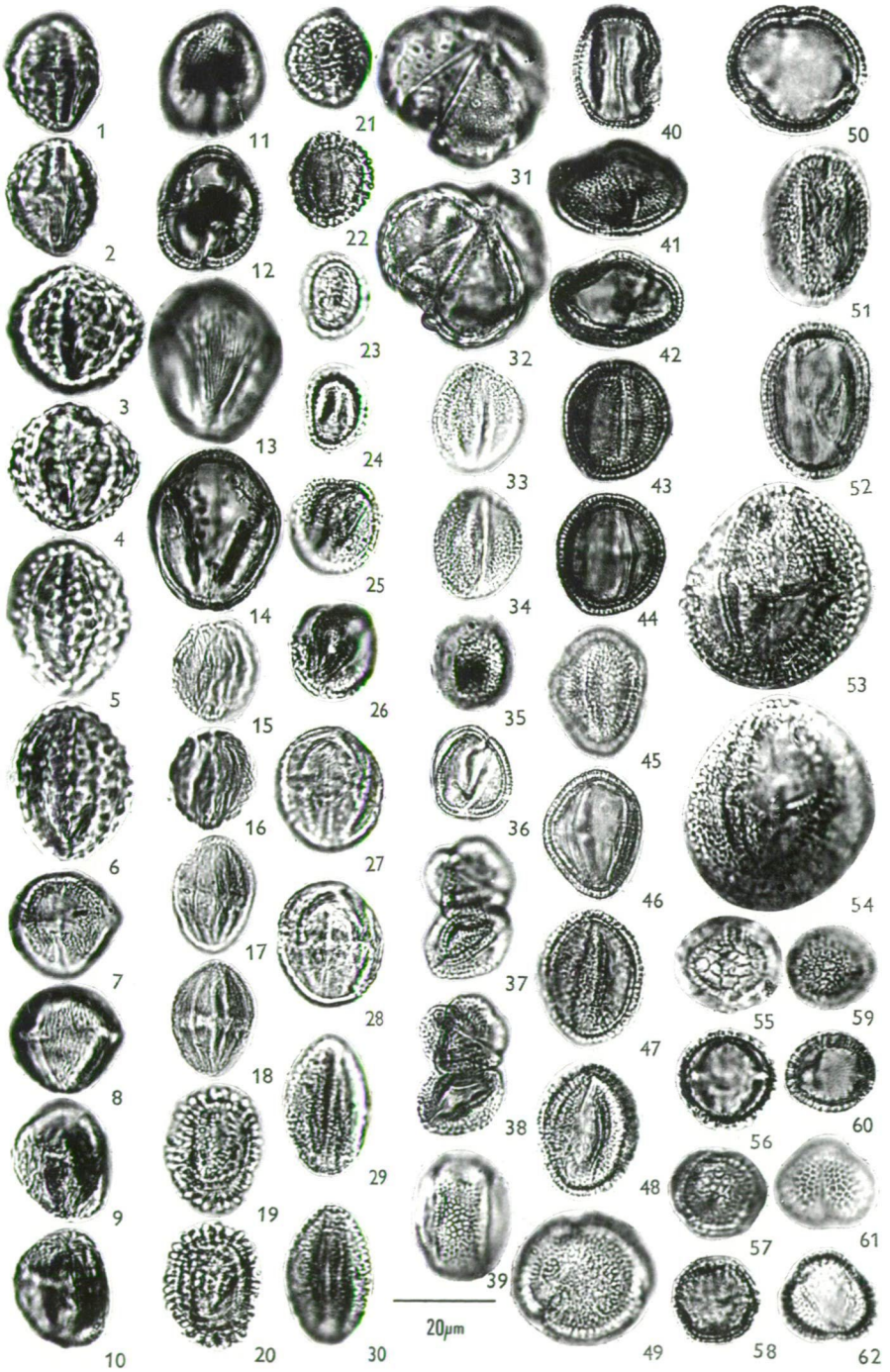
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Planche 3.1.

2. *Foveotricolporites gruas-cavagnettoae* KEDVES 1978
(Planche 3.1., fig. 29,30)
Présence: Sparnacien moyen: Sinceny 21/6-12; Lutétien supérieur: Paris, Austerlitz.
Appartenance botanique probable: cf. *Rhamnaceae.*
3. *Foveotricolporites* fsp.
(Planche 3.1., fig. 31,32)
Présence: Sparnacien moyen: Chavot.
Appartenance botanique probable: *Caesalpiniaceae.*

Fgen.: *Retitricolporites* (VAN DER HAMMEN 1956) VAN DER HAMMEN et WIJMSTRA 1964

1. *Retitricolporites nagyae* KEDVES 1978
(Planche 3.1., fig. 33-38)
Présence: Thanétien, zone II: Anizy-le-Château; Sparnacien moyen: Chavot.
Appartenance botanique probable: *Adoxaceae.*
2. *Retitricolporites potoniei* KEDVES 1978
(Planche 3.1., 39-48)

Planche 3.1.

1,2. *Verrutricolporites ovalis* (R. POTONIÉ 1934) KEDVES 1978, *Fabaceae*, prep.: Nointel 2a.
3,4. *Verrutricolporites ovalis* (R. POTONIÉ 1934) KEDVES 1978, *Fabaceae*, prep.: 21/6-18.
5,6. *Verrutricolporites ovalis* (R. POTONIÉ 1934) KEDVES 1978, *Fabaceae*, prep: Nointel 2a.
7,8. *Striatricolporites striatus* (SIMONCSICS 1964) KEDVES 1978, prep.: 21/6-12.
9,10. *Striatricolporites striatus* (SIMONCSICS 1964) KEDVES 1978, prep.: N-46-L-183-2c-118-2.
11,12. *Striatricolporites pseudoaceroides* (GRUAS-CAVAGNETTO 1968) KEDVES 1978, cf. *Aceraceae*, prep.: AT-1.
13,14. *Striatricolporites striatopunctatus* (KRUTZSCH et VANHOORNE 1977) n. comb., prep.: Fosses 1/1.
15,16. *Striatricolporites solé de portai* (KEDVES 1965) KEDVES 1978, *Fabaceae*, prep.: Cuise 2/2.
17,18. *Striatricolporites solé de portai* (KEDVES 1965) KEDVES 1978, *Fabaceae*, prep.: B1-32-2.
19,20. *Ilexpollenites margaritatus* (R. POTONIÉ 1931a) THIERGART 1937 f. *medius* PFLUG et THOMSON 1953, *Aquifoliaceae, Ilex*, prep.: N-46-L-183-2c-118-2.
21,22. *Ilexpollenites margaritatus* (R. POTONIÉ 1931a) THIERGART 1937 f. *medius* PFLUG et THOMSON 1953, *Aquifoliaceae, Ilex*, prep.: N-46-183-2c-118-1.
23,24. *Ilexpollenites nakomani* KEDVES 1978, cf. *Aquifoliaceae*, prep.: 21/6-18.
25,26. *Ilexpollenites erdtmani* KEDVES 1978, *Aquifoliaceae*, prep.: B1-32-1.
27,28. *Foveotricolporites snopkovae* KEDVES 1978, *Euphorbiaceae*, prep.: Austerlitz 1/1.
29,30. *Foveotricolporites gruas-cavagnettoae* KEDVES 1978, cf. *Rhamnaceae*, prep.: Austerlitz 1/1.
31,32. *Foveotricolporites* fsp., *Caesalpiniaceae*, prep.: Chavot 1/1.
33,34. *Retitricolporites nagyae* KEDVES 1978, *Adoxaceae*, prep.: Chavot 1/2.
35,36. *Retitricolporites nagyae* KEDVES 1978, *Adoxaceae*, prep.: AT-3.
37,38. *Retitricolporites nagyae* KEDVES 1978, *Adoxaceae*, prep.: 21/6-3b.
39,40. *Retitricolporites potoniei* KEDVES 1978, cf. *Punicaceae*, prep.: N-46-L-183-2c-118-2.
41,42. *Retitricolporites potoniei* KEDVES 1978, cf. *Punicaceae*, prep.: B1-32-1.
43,44. *Retitricolporites potoniei* KEDVES 1978, cf. *Punicaceae*, prep.: N-37-L-118-2c-118-1.
45,46. *Retitricolporites potoniei* KEDVES 1978, cf. *Punicaceae*, prep.: Chavot 1/2.
47,48. *Retitricolporites potoniei* KEDVES 1978, cf. *Punicaceae*, prep.: N-37-L-183-2c-118-1.
49,50. *Retitricolporites andreanszkyi* KEDVES 1978, cf. *Menispermaceae*, prep.: B1-32-1.
51,52. *Retitricolporites andreanszkyi* KEDVES 1978, cf. *Menispermaceae*, prep.: N-46-L-183-2c-118-2.
53,54. *Retitricolporites manumi* KEDVES 1978, prep. Austerlitz 1/3.
55,56. *Retitricolporites wodehousei* KEDVES 1978, prep.: B1-6-1.
57,58. *Retitricolporites wodehousei* KEDVES 1978, prep.: N-46-L-183-2c-118-2.
59,60. *Retitricolporites wodehousei* KEDVES 1978, prep.: N-46-L-183-2c-118-2.
61,62. *Retitricolporites wodehousei* KEDVES 1978, prep.: 21/6-12.

Présence: Thanétien, zone II: Anizy-le-Château; Sparnacien moyen: Boulogne-la-Grasse 21/6-18, Chavot; Sparnacien supérieur: Guitrancourt B1-32, Neuilly-46, Neuilly-37.

Appartenance botanique probable: cf. *Punicaceae*.

3. *Retitricolporites andreanszkyi* KEDVES 1978
(Planche 3.1., fig. 49-52)

Présence: Sparnacien moyen: Boulogne-la-Grasse 21/6-18; Sparnacien supérieur: Neuilly-46.

Appartenance botanique probable: cf. *Menispermaceae*.

4. *Retitricolporites manumi* KEDVES 1978
(Planche 3.1., fig. 53,54)

Présence: Lutétien supérieur: Paris, Austerlitz.

5. *Retitricolporites wodehousei* KEDVES 1978
(Planche 3.1., fig. 55-62)

Présence: Sparnacien inférieur: Arpenty B1-118; Sparnacien moyen: Sinceny 21/6-12; Sparnacien supérieur: Neuilly-46. Sparnacien, Facies Argiles des Flandres: Watten B1-6.

6. *Retitricolporites macrodurensis* (THOMSON et PFLUG 1953) ROCHE et SCHULER 1976
(Planche 3.2., fig. 1,2)

Planche 3.2.

1,2. *Retitricolporites macrodurensis* (THOMSON et PFLUG 1953) ROCHE et SCHULER 1976, *Araliaceae*, prep.: Chavot 1/2.
3,4. *Retitricolporites europaeus* (KRUTZSCH et VANHOORNE 1977) n. comb., prep.: 21/6-6a-2.
5,6. *Retitricolporites europaeus* (KRUTZSCH et VANHOORNE 1977) n. comb., prep.: 21/6-6a-2.
7,8. *Retitricolporites staresedloensis* (KRUTZSCH et PACLTOVÁ 1969) n. comb., prep.: AT-14.
9,10. *Retitricolporites densireticulatus* (TREVISAN 1967) KEDVES 1978 subfsp. *minor* KEDVES 1978, ? *Aquifoliaceae*, prep.: Austerlitz 1/1.
11,12. *Retitricolporites densireticulatus* (TREVISAN 1967) KEDVES 1978 subfsp. *minor* KEDVES 1978, ? *Aquifoliaceae*, prep.: AT-10.
13,14. *Retitricolporites densireticulatus* (TREVISAN 1967) KEDVES 1978 subfsp. *minor* KEDVES 1978, ? *Aquifoliaceae*, prep.: 21/6-6a-10.
15,16. *Retitricolporites densireticulatus* (TREVISAN 1967) KEDVES 1978 subfsp. *minor* KEDVES 1978, ? *Aquifoliaceae*, prep.: N-46-L-183-2c-118-2.
17,18. *Retitricolporites densireticulatus* (TREVISAN 1967) KEDVES 1978 subfsp. *minor* KEDVES 1978, ? *Aquifoliaceae*, prep.: Austerlitz1/1.
19,20. *Caprifoliacidites* fsp., prep.: 21/6-18.
21,22. *Nagyipollis globus* KEDVES 1962, *Euphorbiaceae*, prep.: Austerlitz 1/3.
23,24. *Oligopollis* fsp., prep.: N-37-L-118-2c-118-1.
25,26. *Oligopollis* fsp., prep.: Cuise 2/2.
27,28. *Tetracolporopollenites olaszfaluensis* KEDVES 1978, *Sapotaceae*, prep.: B1-32-2.
29,30. *Tetracolporopollenites balinkaense* KEDVES 1978, *Sapotaceae*, prep.: Chavot 1/1.
31,32. *Tetracolporopollenites manifestus* (R. POTONIÉ 1931b) THOMSON et PFLUG 1953 subfsp, *contractus* PFLUG 1953, *Sapotaceae*, prep.: Austerlitz 1/1.
33,34. *Tetracolporopollenites hungaricus* KEDVES 1965, *Sapotaceae*, prep.: B1-32-2.
35,36. *Tetracolporopollenites cf. kirchheimeri* (REISSINGER 1951) THOMSON et PFLUG 1953, *Sapotaceae*, prep.: Austerlitz 1/3.
37,38. *Polycolporopollenites* fsp., prep.: B1-25-1.
39,40. *Ericipites callidus* (R. POTONIÉ 1931b) KRUTZSCH 1970, *Ericaceae*, prep.: AT-17.
41,42. *Ericipites insleyanus* (TRAVERSE 1955) KRUTZSCH 1970, *Ericaceae*, prep.: Austerlitz 1/3.
43,44. *Ericipites insleyanus* (TRAVERSE 1955) KRUTZSCH 1970, *Ericaceae*, prep.: Austerlitz 1/1.
45,46. *Acaciapollenites* fsp., *Mimosaceae*, prep.: 21/6-12.
47,48. *Poropolyadopollenites* fsp., prep.: 21/6-12.
49,50. *Poropolyadopollenites* fsp., prep.: Nointel 2.

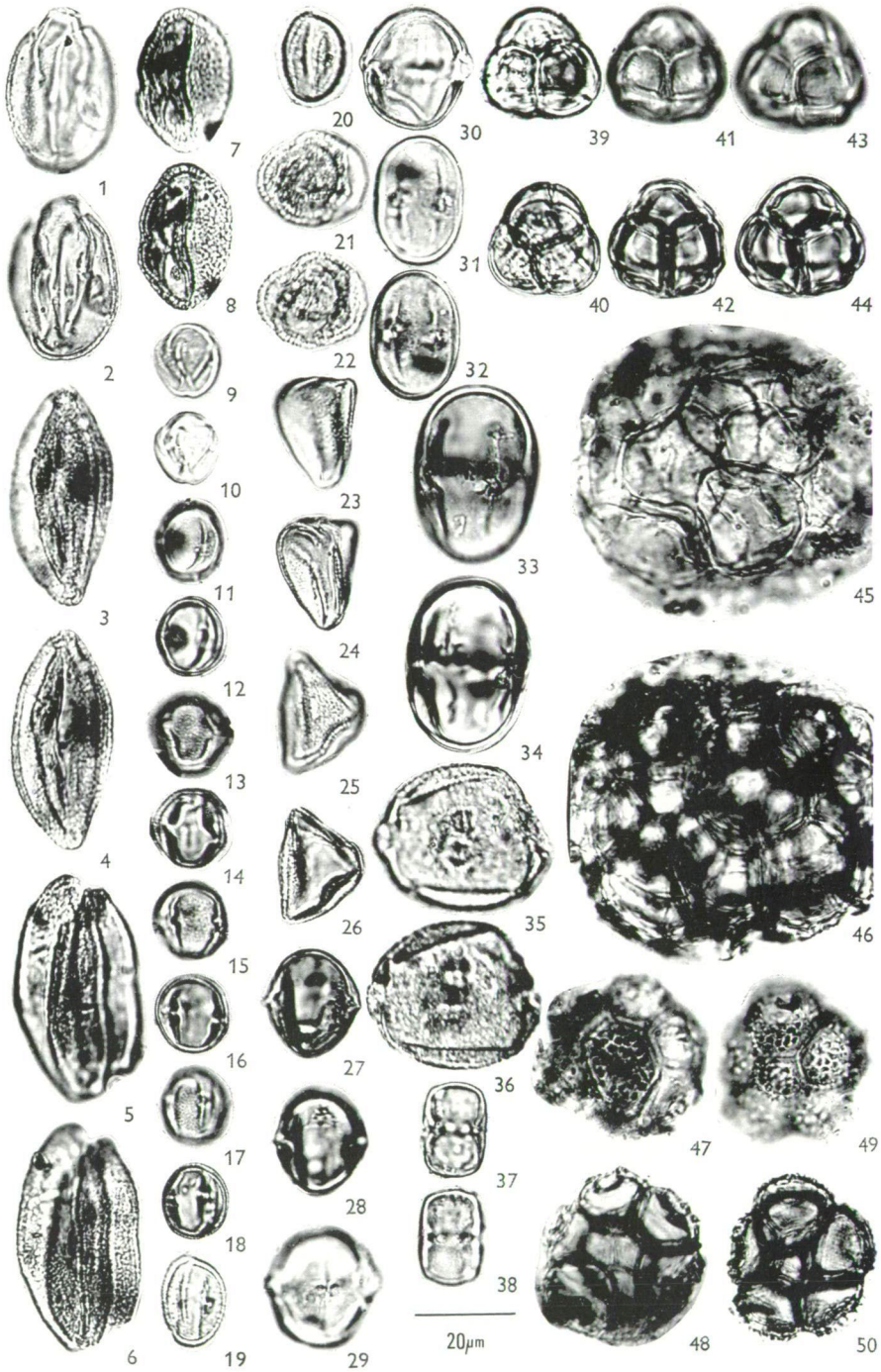
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Planche 3.2.

Présence: Sparnacien moyen: Chavot.
Appartenance botanique probable: *Araliaceae.*

7. *Retitricolporites europaeus* (KRUTZSCH et VANHOORNE 1977) n. comb.
(Planche 3.2., fig. 3-6)

Syn.: 1977, KRUTZSCH et VANHOORNE, *Tricolporopollenites europaeus* n. fsp., p. 72, pl. 30, 11-18, cf. 19-22.

Présence: Sparnacien inférieur: Saint Léger-aux-Bois 21/6-6a.

8. *Retitricolporites staresedloensis* (KRUTZSCH et PACLTOVÁ 1969) n. comb.
(Planche 3.2., fig. 7,8)

Syn.: 1969, KRUTZSCH et PACLTOVÁ, in KRUTZSCH. *Tricolporopollenites staresedloensis* n. fsp., p. 474, pl. II, 25-37.

Présence: Thanétien, zone II: Anizy-le-Château; Sparnacien, Facies Argiles des Flandres: Watten B1-6.

9. *Retitricolporites densireticulatus* (TREVISAN 1967) KEDVES 1978 subfsp. *minor* KEDVES 1978
(Planche 3.2., fig. 9-18)

Présence: Thanétien, zone II: Anizy-le-Château; Thanétien, zone III: Rollot 21/6-16; Sparnacien inférieur: Saint Léger-aux-Bois 21/6-6a; Sparnacien supérieur: Neuilly-46; Lutétien supérieur: Paris, Austerlitz.

Fgen.: *Caprifoliacidites* SAH 1967

1. *Caprifoliacidites* fsp.
(Planche 3.2., fig. 19,20)
Présence: Sparnacien moyen: Boulogne-la-Grasse 21/6-18.

Fgen.: *Nagyipollis* KEDVES 1962

1. *Nagyipollis globus* KEDVES 1962
(Planche 3.2., fig. 21,22)
Présence: Lutétien supérieur: Paris, Austerlitz.
Appartenance botanique probable: *Euphorbiaceae.*

Fgen.: *Oligopollis* KRUTZSCH 1959

1. *Oligopollis* fsp.,
(Planche 3.2., fig. 23-26)
Présence: Sparnacien moyen: Sinceny 21/6-12; Cuisien supérieur: Cuise-2.

Fgen.: *Tetracolporopollenites* PFLUG et THOMSON 1953

1. *Tetracolporopollenites olaszfaluensis* KEDVES 1978
(Planche 3.2., fig. 27,28)
Présence: Sparnacien supérieur: Guitrancourt B1-32.
Appartenance botanique probable: *Sapotaceae.*
2. *Tetracolporopollenites balinkaense* KEDVES 1978
(Planche 3.2., fig. 29,30)
Présence: Sparnacien moyen: Chavot; Lutétien supérieur: Paris, Austerlitz.
Appartenance botanique probable: *Sapotaceae.*

3. *Tetracolporopollenites manifestus* (R. POTONIÉ 1931b) THOMSON et PFLUG 1953 subfsp. *contractus* PFLUG 1953
(Planche 3.2., fig. 31,32)
Présence: Lutétien supérieur: Paris, Austerlitz.
Appartenance botanique probable: *Sapotaceae.*
4. *Tetracolporopollenites hungaricus* KEDVES 1965
(Planche 3.2., fig. 33,34)
Présence: Sparnacien supérieur: Guitrancourt B1-32; Sparnacien, Facies Argiles des Flandres: Watten B1-6.
Appartenance botanique probable: *Sapotaceae.*
5. *Tetracolporopollenites* cf. *kirchheimeri* (REISSINGER 1951) THOMSON et PFLUG 1953
(Planche 3.2., fig. 35,36)
Présence: Lutétien supérieur: Paris, Austerlitz.
Appartenance botanique probable: *Sapotaceae.*

Fgen.: *Polycolporopollenites* KEDVES 1965

Note. - Homonym in ROCHE (1973), p. 87.
1. *Polycolporopollenites* fsp.
(Planche 3.2., fig. 37,38)
Présence: Sparnacien, Facies Argiles des Flandres: Templeuve-en-Pévèle B1-25.

Fgen.: *Ericipites* WODEHOUSE 1933

1. *Ericipites callidus* (R. POTONIÉ 1931b) KRUTZSCH 1970
(Planche 3.2., 39,40)
Présence: Thanétien, zone II: Anizy-le-Château.
Appartenance botanique probable: *Ericaceae.*
2. *Ericipites insleyanus* (TRAVERSE 1955) KRUTZSCH 1970
(Planche 3.2., fig. 41-44)
Présence: Sparnacien, Facies Argiles des Flandres: Watten B1-6; Lutétien supérieur: Paris, Austerlitz.
Appartenance botanique probable: *Ericaceae.*

Fgen.: *Acaciapollenites* MILDENHALL 1972

Note. - Des documents supplémentaires concernant les pollens fossiles des polyades voir dans l'étude de CARATINI et GUINET (1973) et GUINET et SALARD-CHEBOLDAEFF (1975).
1. *Acaciapollenites* fsp.
(Planche 3.2., fig. 45,46)
Présence: Sparnacien moyen: Sinceny 21/6-12.
Appartenance botanique probable: *Mimosaceae.*

Fgen.: *Poropolyadopollenites* KEDVES 1978

1. *Poropolyadopollenites* fsp.
(Planche 3.2., fig. 47-50)
Présence: Sparnacien moyen: Sinceny 21/6-12; Sparnacien supérieur: Nointel.

À suivre

Cette étude a été publiée avec le concours du Crédit OTKA 1/7 T 014692.

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4. WOOD ANATOMY OF HUNGARIAN TERTIARY LIGNITES

M. KEDVES

Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J. A. University, H-6701, P. O. Box 993, Szeged, Hungary

Abstract

Ten lignit samples of different localities and different preservation state were investigated with light microscope. Nine samples are of *gymnospermous* origin (*Taxodiaceae*), and only one *angiosperm (Betulaceae)* woody remnant was observed. Based on the results of the presented samples six were selected for partial dissolution experiment and for transmission electron microscopical investigations.

Key words: Xylotomy, LM anatomy, Tertiary, Hungary.

Introduction

The LM results presented in this contribution are within the combined research program of our Laboratory. The method and the first LM wood anatomical data were published previously (KEDVES, 1997). The first TEM results of this research program are presented in this volume (KEDVES and PÁRDUTZ, 1999).

The aim of this paper is:

1. to determine ten different samples based on the wood anatomical characteristic features.
2. to investigate the different kind of preservation of the fossil wood for the selection of partial dissolution and transmission electron microscopical investigations.

Materials and Methods

The samples of this part of the research program were collected by Dr. M. SZÓNOKY (Department of Geology and Paleontology of the J.A.University, Szeged, Hungary). Thin slides, and macerated lignit samples were investigated by light microscope. The localities and other documents of the material of investigation will be presented together with the most important anatomical descriptions.

Results

Sample no 3 (Plate 4.1., figs. 1-6)

Locality: Mohács, Upper Pannonian, brick-works, lower level.

Plate 4.1.

1-6. Sample no 3, *Sequoioxylon gypsaceum* (GÖPPERT) GREGUSS 1967.
1. Cross section, 250x.
2. Tangential section, 250x.
3. Horizontal wall of the longitudinal parenchyma, 500x.
4. Radial section, bordered pits, 1.000x.
5,6. Radial sections, cross-field pits, 1.000x.
7-10. Sample no 11, *Sequoioxylon gypsaceum* (GÖPPERT) GREGUSS 1967.
7. Cross section, 250x.
8. Tangential section. 250x.
9. Longitudinal parenchyma, illustrated are the horizontal wall and the resin drops, 1.000x.
10. Radial section, 1.000x.

Plate 4.2.

1-3. Sample no 10, *Sequoioxylon gypsaceum* (GÖPPERT) GREGUSS 1967.
1. Cross section, 250x.
2. Tangential section, 1.000x.
3. Radial section, 1.000x.
4-7. Sample no 12, *Sequoioxylon medullare* (GÖPPERT) GREGUSS 1967.
4. Cross section, 250x.
5. Cross section, 1.000x.
6. Tangential section, 250x.
7. Radial section, 500x.

Plate 4.3.

1-4. Sample no 7, *Sequoioxylon medullare* (GÖPPERT) GREGUSS 1967.
1. Cross section. 500x.
2. Tangential section, 250x.
3. Tangential section, horizontal wall of the longitudinal parenchyma, 1.000x.
4. Radial section, 1.000x.
5,6. Sample no 4, *Sequoioxylon gypsaceum* (GÖPPERT) GREGUSS 1957.
5. Tangential section, 500x.
6. Radial section, 1.000x.

Plate 4.4.

1,2. Sample no 5, *Sequoioxylon medullare* (GÖPPERT) GREGUSS 1967.
1. Tangential section, horizontal wall of the longitudinal parenchyma, 1.000x.
2. Radial section pitting of the cross fields, 1.000x.
3,4. Sample no 9, *Sequoioxylon medullare* (GÖPPERT) GREGUSS 1967, radial sections, 1.000x.

Plate 4.5.

1,2. Sample no 6, *Sequoioxylon medullare* (GÖPPERT) GREGUSS 1967, radial sections, 1.000x.
3-5. Sample no 8, *Alnus*
3,5. Scalariform perforations of vessel, 1.000x.
4. Multiseriate pitting of vessel, 1.000x.

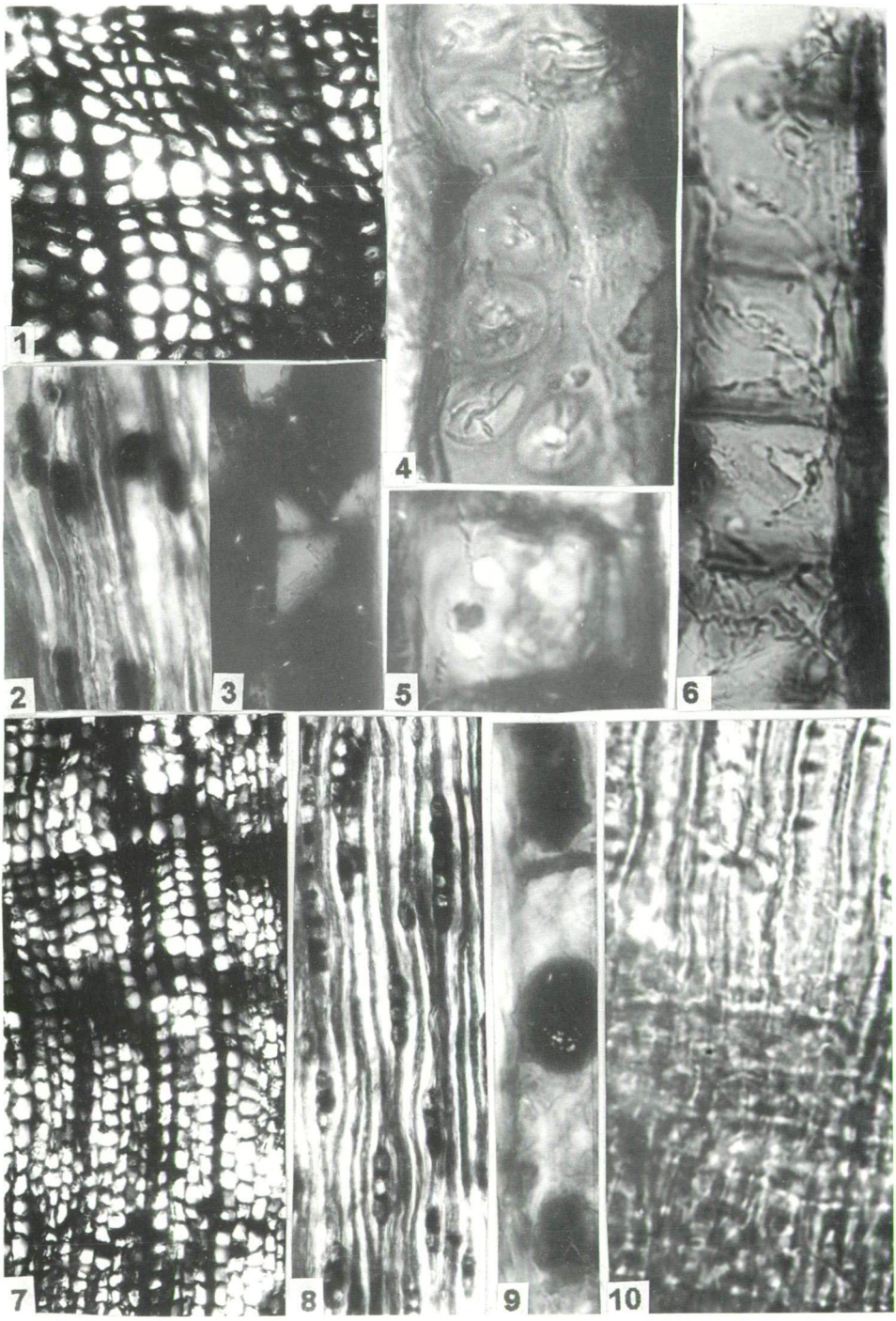


Plate 4.1.

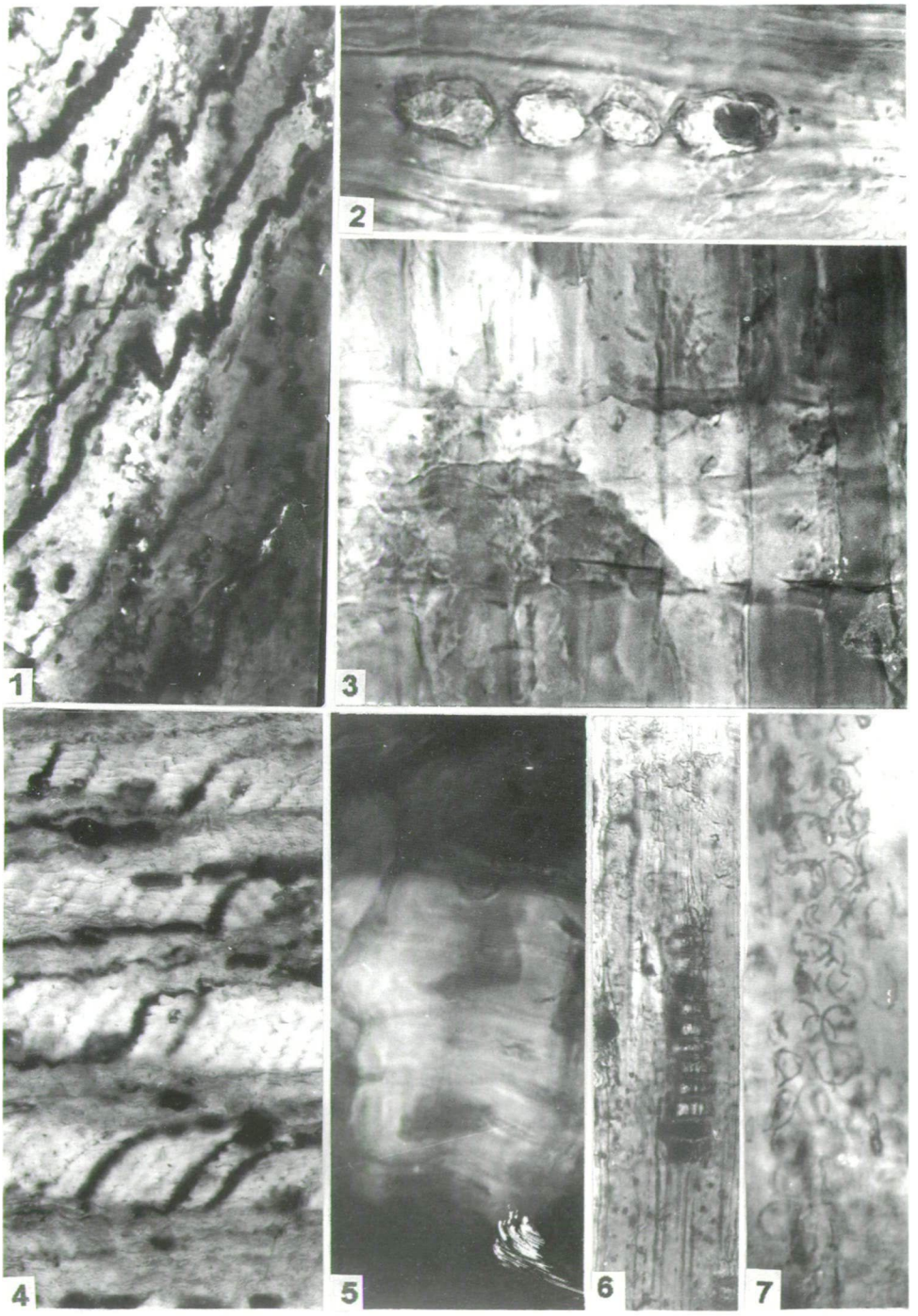


Plate 4.2.

Plate 4.3.

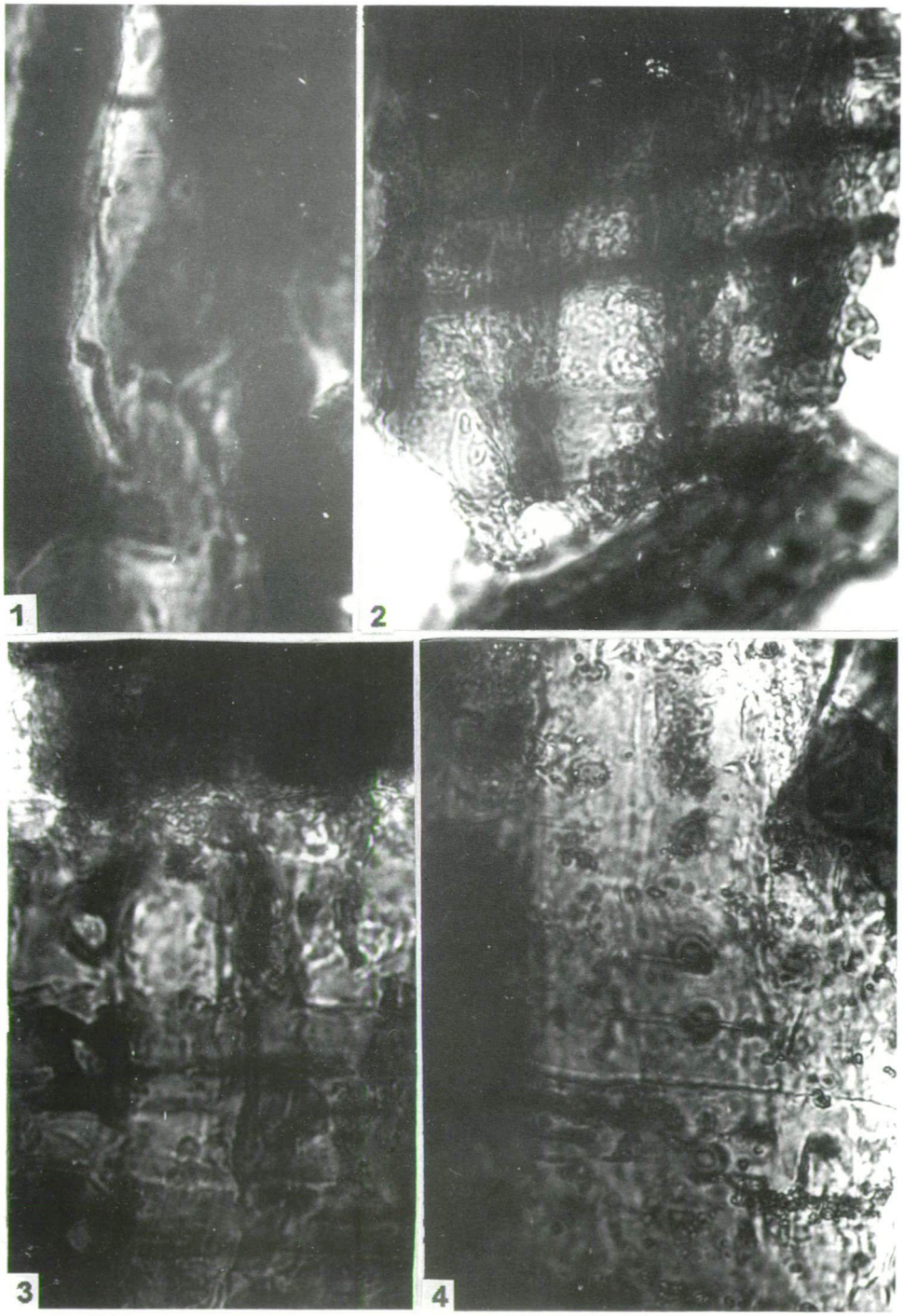


Plate 4.4.

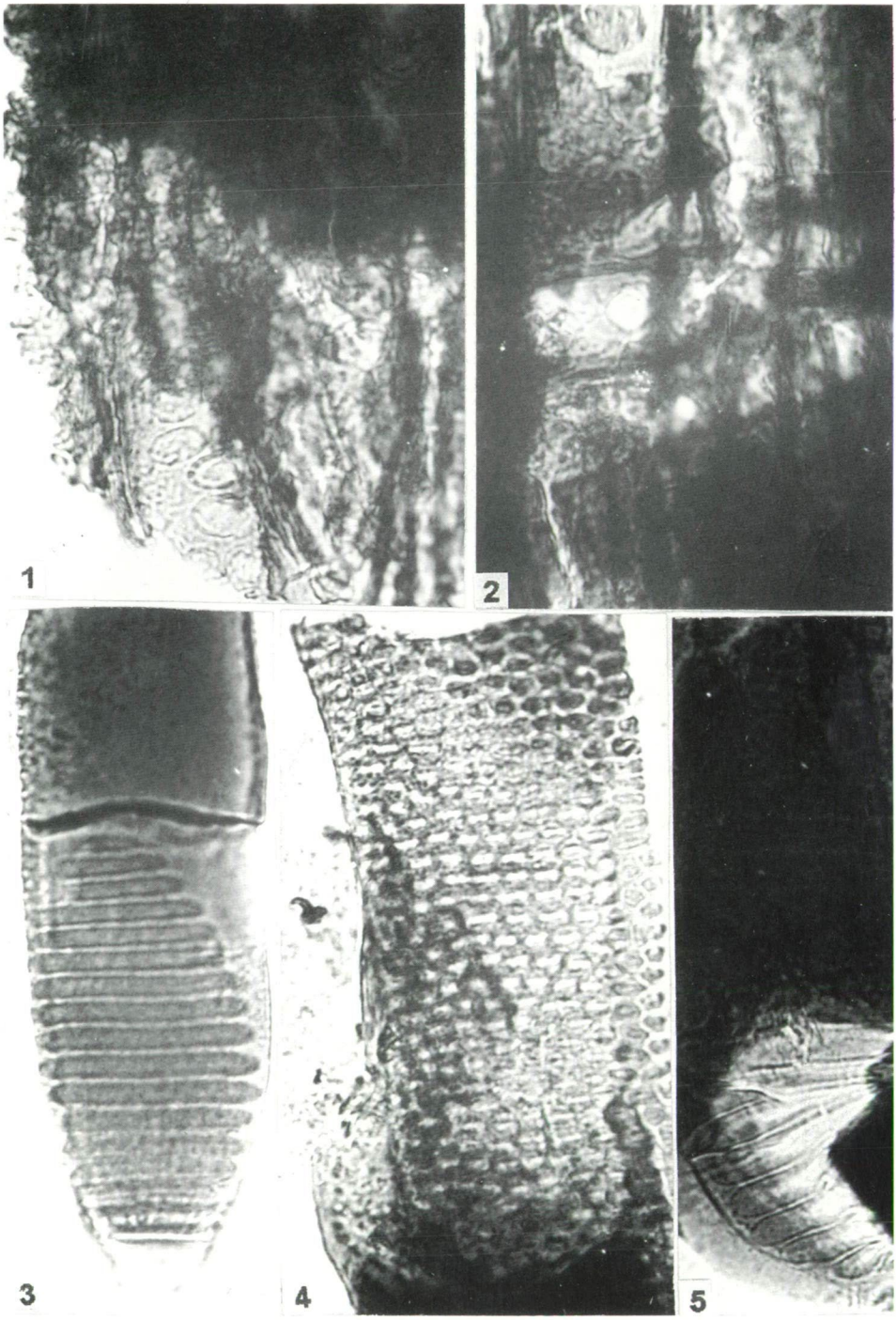


Plate 4.5.

LM anatomy. - The secondary wood is carbonified. The annual rings are narrow about 2-5 tracheids wide (Plate 4.1., fig. l). The rays are uniseriate and 1-6 cells high, 49 per cent of the rays are 2 cells high. The quantitative data are summarized in text-fig. 4.2. The ray cells are full of reddish-brown resin content (Plate 4.1., fig. 2). The horizontal walls of the parenchyma are smooth (Plate 4.1., fig. 3). The bordered pits are arranged in one or in two rows (Plate 4.1., fig. 4). In one cross fields there are 2-4 taxodioid pits (Plate 4.1., figs. 5,6).

Sample no 11 (Plate 4.1., figs. 7-10)

Locality: Bátaszék, Upper Pannonian, layer D-1/L.

LM anatomy. - Similar to the previous one. The ray cells are not completely full of resin content (Plate 4.1., fig. 8). The quantitative data of the per cents of cells of different height are summarized in text-fig. 4.2. The horizontal walls of the parenchyma are smooth (Plate 4.1., fig. 9). The resin content of the longitudinal parenchyma cells is in drops. The pits of the radial wall of the tracheids are similar to the previous samples.

Sample no 10 (Plate 4.2., figs.1-3)

Locality: Bátaszék, Upper Pannonian, layer D-1/B.

LM anatomy. - The structure of the secondary wood is altered during the fossilization and compressed. In general the late wood is in more or less is well preserved. The annual ring was definite, in the late wood there are about 4-6-10 seriate thick walled tracheids with narrow lumina (Plate 4.2., fig. 1). The ray cells are uniseriate and 1-11 cells high, 42.5 per cent of the rays are 2 cells high, quantitative data are in text-fig. 4.2. The horizontal walls of the parenchyma are smooth, the resin content in drops. The bordered pits of the late wood are arranged in one row. In the cross fields there are generally two taxodioid pits (Plate 4.2., fig. 3).

Sample no 12 (Plate 4.2., figs. 4-7)

Locality: Bátaszék, western profile, Upper Pannonian.

LM anatomy. - The structure of the secondary wood is damaged and compressed during the fossilization process (Plate 4.2., figs. 4,5). The tracheids of the late wood are 6-8-10 seriate. Sometimes there are light walled fields in the late wood (Plate 4.2., fig. 5). The ray cells are uniseriate and 1-15 cells high. The quantitative data are completely different in contrast to the previous samples (Text-fig. 4.2.). The 4-7 cells high rays are in the highest quantity (15.3, 15.0, 14.0%). There are resin drops in the parenchyma, the horizontal walls are smooth. The pits of the radial wall of the tracheids are biseriate (Plate 4.2., fig. 7). In the cross fields there are in general two taxodioid pits.

Sample no: 7 (Plate 4.3., figs. 1-4)

Locality: Bátaszék, well no 7, depth 168.0 m., Upper Pannonian.

LM anatomy. - The structure of the secondary wood is carbonified and damaged. (Plate 4.3., fig. 1). The late wood of the annual rings is 3-6 tracheids wide. The ray cells are uniseriate and 1-16 cells high (Plate 4.3., figs. 2,3). The quantitative data are illustrated in text-fig. 4.2. Rays of 2 cells high are in the greatest quantity (35.0%). The horizontal walls of the parenchyma are smooth, (Plate 4.3., fig. 3) there are resin drops in it (Plate 4.3., fig. 2). The pits of the radial wall of the tracheids are not so well discernible, but uniseriate. In the cross fields there are about two probably taxodioid pits (Plate 4.3., fig. 4).

Sample no: 4 (Plate 4.3., figs. 5,6)

Locality: Keresztespuszta, well no 1, depth 230.7 m., Upper Pannonian.

LM anatomy. - The structure of the secondary wood is compressed and disorganized. In general taxonomically important anatomical characteristic features were observed at the late wood. The ray cells are uniseriate and 1-16 cells high (Plate 4.3., fig. 5), text-fig. 4.2. The horizontal walls of the parenchyma are smooth, and there are great resin drops in these cells. The pits of the radial wall of the tracheids are arranged in two rows. In the cross fields there are 4-5 taxodioid or cupressoid pits (Plate 4.3., fig. 6).

Sample no: 5 (Plate 4.4., figs. 1,2)

Locality: Abaliget, well no 5, depth 297.8-211.7 m., 2nd coal layer., Upper Pannonian.

LM anatomy. - The structure of the lignit sample is disorganized, invesigations were made only by macerated fragments. The horizontal walls of the parenchyma are smooth (Plate 4.4., fig. 1). The bordered pits of the radial wall of the tracheids are generally arranged in one or two rows. There are 2-4 taxodioid pits in the cross fields (Plate 4.4., fig. 2).

Sample no: 9 (Plate 4.4., figs. 3,4)

Locality: Bátaszék, layer Ny-3, "big tree-trunk", Upper Pannonian.

LM anatomy. - Similarly to the previously discussed sample the anatomical characteristic features were discernible at the late wood. The number of the ray cells is relatively high. The pits of the radial wall of the tracheids are generally uniseriate. In the cross fields there are 2-4 pits of taxodioid or cupressoid character. (Plate 4.4., fig. 4).

Sample no: 6 (Plate 4.5., figs. 1,2)

Locality: Bátaszék., well no 3, depth 220.0 m., Upper Pannonian.

LM anatomy. - Based on the observation of macerated fragments this lignit sample is also of *Taxodiaceae* (probably *Sequoia*) origin. The horizontal walls of the parenchyma are smooth. The number of the ray cells is relatively high. The bordered pits of the radial wall of the tracheids are arranged in two rows (Plate 5.5., fig. 1). In the cross fields there are 2 taxodioid pits (Plate 5.5., fig. 2).

Sample no: 8 (Plate 5.5., figs. 3-5)

Locality: Bátaszék, well no 37, depth 92 m., Upper Pannonian.

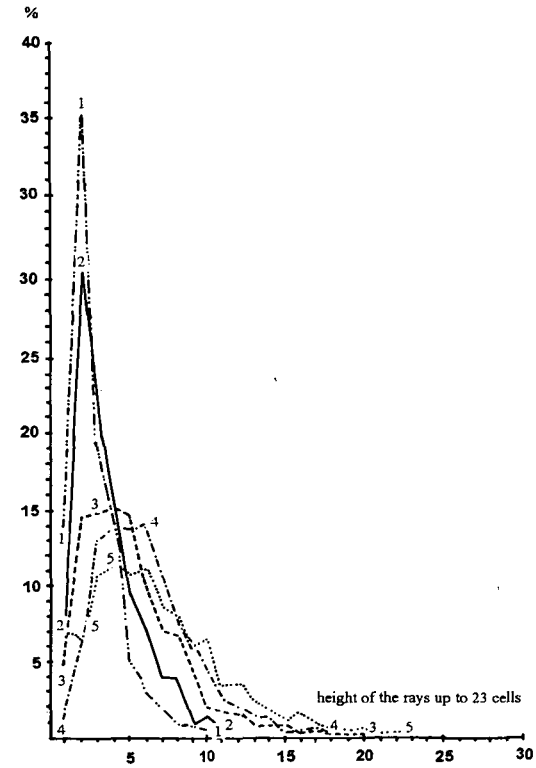
LM anatomy. - The sample was very small, it was impossible to prepare thin slides from it. Based on the study of the macerated fragments *angiosperm* wood may be determined. Characteristic scalariform perforations of vessel (Plate 4.5., figs. 3,5) and characteristic pitting (Plate 4.5., fig. 4).

Discussion and Conclusions

1. Botanical affinities of the investigated samples.

1.1. *Gymnosperm* woods. Nine samples are in all probability of *Taxodiaceae* origin. The more or less well preserved samples may be compared with the recent *Sequoia* genus. For the determinations of the *gymnosperm* woods we used as one of the anatomical characteristic features the graphs of the per cents of height of the rays. This method was used for the characterization of the Hungarian lignites by MAÁCZ (1955a), and HARASZTY (1957,1958a). In another paper, HARASZTY (1958b) applied this method for lignit samples of Romania. To this it is necessary to emphasize the statements of

MAÁCZ (1955b) on the secondary wood of the recent *Metasequoia glyptostroboides*. Important differences were established in this point of view between the anatomy of the trunk and the branch. The text-figure of the writer (KEDVES, 1959) with the previous data are republished herein (Text-fig. 4.1). In this paper two types were distinguished such as: *Sequoioxylon* cf. *gigantea* and *Sequoioxylon* cf. *sempervirens*, in comparison to *Sequoia gigantea*, and *Sequoia sempervirens*. Regarding the results of our recent investigations we can establish the following (Text-fig. 4.2.):



Text-fig. 4.1.

Graphs of the percentages of the height of the rays of recent and fossil *Sequoia* taxa. This figure was published first in the paper of KEDVES (1959), the redrawn form is presented herein for comparison.

1. *Sequoioxylon* cf. *gigantea*, fossil.
2. *Sequoia gigantea* , recent.
3,4. *Sequoioxylon* cf. *sempervirens*, fossil.
5. *Sequoia sempervirens*, recent.

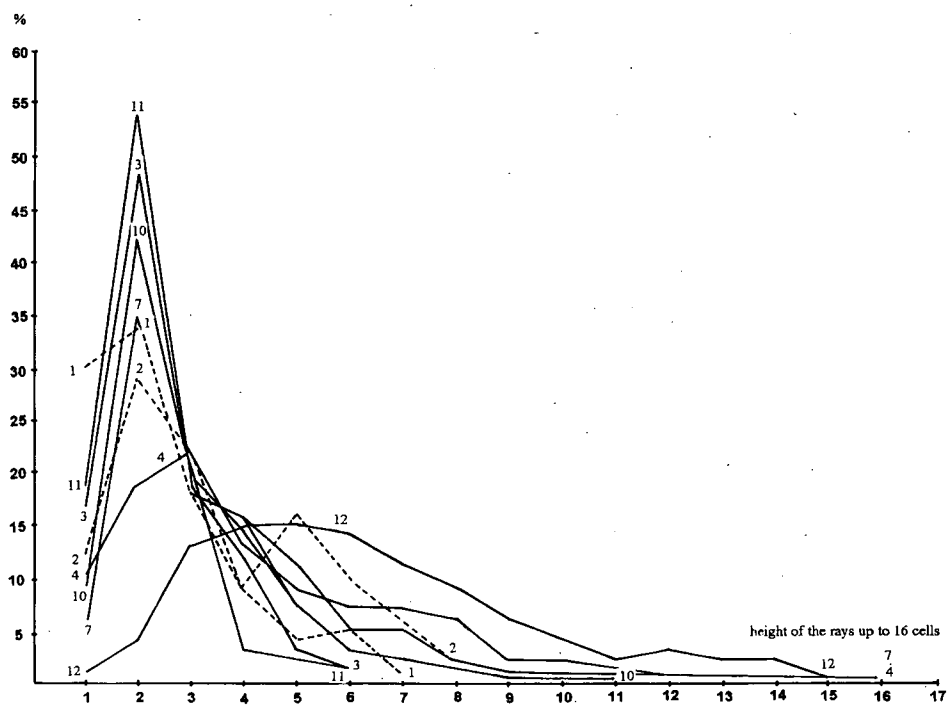
Two types may be distinguished: The first one is more or less identical or similar to the "*Sequoioxylon* cf. *gigantea*" type. Samples no 1, 7, 10, 3 and 11 may be classed into this group. Sample no 2 in this point of view represents an intermediate type between the *S. gigantea* and *S. sempervirens* group. Finally samples no 4 and 12 are similar to the *S. sempervirens* type. Sample no 1 was determined previously as *Sequoioxylon gypsaceum* (GÖPPER) GREGUSS 1967, and sample no 2 as *S. medullare* GREGUSS 1967.

Taking into consideration further anatomical characteristics, particularly the pits in the cross fields the investigated *gymnospermous* samples were determined as follows:

Sequoioxylon gypsaceum (GÖPPERT) GREGUSS 1967, samples: l, 3, 10, 11, 4.

Sequoioxylon medullare GREGUSS 1967, samples: 2, 12, 7, 5, 9, 6.

Based on our present day knowledge we can point out that sample no 4 is interesting in wood anatomical point of view. But on the other hand we must take into consideration that the preservation of this sample is not so good.



Text-fig. 4.2.

Graphs of the percentages of the height of the rays of the samples investigated within this program. The anatomical description of the samples no 1 and 2 was published previously (KEDVES, 1997).

As regards the nomenclature of the fossil *Sequoia* wood remains there are different concepts. Some selected one are as follows: GRABOWSKA (1956) described very well preserved wood remnant as *Taxodioxylon gypsaceum* (GÖPPERT) KRÄUSEL, and enumerated several previous bibliographical data. The number of the pits in the cross-fields is generally 2. HARASZTY (1958) following the terminology of GOTHAN for the fossil woods which are of the *Sequoia sempervirens* type, the species name *Taxodioxylon sequoianum* (syn.: *T. gypsaceum* KRÄUSEL) was used. But later (HARASZTY, 1960) described further fossil woods of this type as *Taxodioxylon gypsaceum*.

Following HUARD (1965), *Taxodioxylon gypsaceum* (GÖPPERT) KRÄUSEL: *Sequoia sempervirens* ENDL., and *Taxodioxylon giganteoides* HUARD: *Sequoiadendron giganteum* (DECAISNE) BUCHHOLZ.

In the paper of PÁLFALVY and RÁKOSI (1979) *Sequoioxylon gypsaceum* (GÖPPERT 1842) GREGUSS 1967 name was used.

From the LM anatomically investigated samples the following samples were selected for further TEM studies: 3, 10, 7, 11, 12, 4.

1.2. *Angiosperm* wood.

In general angiosperm wood remnants are not so common in lignites. To this the paper of HUARD (1966/67) is worth of mentioning. In this paper *Quercoxylon pauciporosum* nov. sp. was described from the Neogene lignite of Arjuzanx (Landes), France. In this paper another *angiosperm* remnant, *Laurinoxylon* FÉLIX was also mentioned. The determination of the fossil *Lauraceae* was published in another paper (HUARD, 1967).

Based on our limited data the botanical affinity of our sample no: 8, the genus *Alnus* is probable (cf. GREGUSS, 1945, 1969).

Acknowledgements

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5. TRANSMISSION ELECTRON MICROSCOPY OF HUNGARIAN TERTIARY LIGNITES I.

M. KEDVES[1] and Á. PÁRDUTZ[2]

1. Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J. A. University, H-6701, P. O. Box 993, Szeged, Hungary, 2. Insitute of Biophysics, Biological Research Center of the Hungarian Academy of Sciences, H-6701, P. O. Box 521, Szeged, Hungary

Abstract

The ultrastructure of two Hungarian Tertiary lignites (*Sequoioxylon gypsaceum* (GÖPPERT) GREGUSS and *Sequoioxylon medullare* GREGUSS 1967) are presented in this paper. The LM structure of the non-experimental and the partially dissolved two lignit samples was published previously. The used two organic solvents (diethylamine, merkaptoethanol) altered the fine structure of the secondary wood. The alterations are not completely identical at the two samples investigated. The ultrastructure of the melanoresin content of the longitudinal parenchyma and the ray cells of *Sequoioxylon medullare* is published herein.

Key words: Xylotomy, transmission electron microscopy, Tertiary, Hungary.

Introduction

As it was emphasized previously (KEDVES, 1997) the light microscopical structure of the Hungarian Tertiary lignites was investigated in several papers. The experimental combined study of several samples by LM and TEM method is a new research program of our Laboratory. This contribution summarizes the first ultrastructure results within this project.

Till this time the TEM method was used for rebedded wood remains isolated from the sediments of the Lake of Soltvadkert (KEDVES and SZEDERKÉNYI, 1988). In this paper the importance of the ultrastructure of the secondary wood fragments in the paleoenvironmental reconstructions was emphasized.

The aim of this paper is to investigate the alterations in the ultrastructure of the lignit samples during the different kinds of sedimentation, and after the partial dissolution with two organic solvents.

General problems

For the fine structure of the wall of the secondary wood there are several schemas. The concept of BOUREAU (1954) was accepted in the great monograph of GREGUSS (1955). Based on the book of JANE (1970) the schema of the microfibrils of the tracheids are as follows:

Middle lamella – there are no microfibrils

Primary wall (P) – the orientation of the microfibrils is rather irregular.
Secondary wall (S)
S1 S helices "right handed"
S2 Z helices "left handed"
S3 S helices

BAMBER and SANGSTER (1977) investigated the sectioning characteristics of normal and gamma-irradiated conifer woods. In this paper the establishments of SEIFERT (1964) were pointed out, namely the lignin is resistant to high levels of gamma irradiation whereas cellulose is rapidly broken down. The SEM pictures of irradiated wood published by ANTOINE, AVELLA and VAN EYSEREN (1971) show better retention of structure than was observed in the sectioned embedded wood. This is the reason why ANTOINE and VAN EYSEREN (1971) proposed a new and easy technique of SEM wood sample preparation using radiation doses higher than 400 Mrad. The polylamellate structure consisting of about 15 successive lamellae is an alternating manner of the parenchyma wall in *Phyllostachys edulis* RIV. was published by PARAMESWARAN and LIESE (1975). CHAFE (1974) emphasized, a considerable variability in parenchyma cell wall of yellow cypress. The TEM method was used for the investigation of the shape and the fine structure of the pits in *Betula alleghaniensis* by KUNG-CHI YOUNG (1978). NEČESANÝ (1979) investigated the fine structure of laser cut surfaces of wood with the SEM method, and the results were compared with the quantity of used energy. FREY-WISSLING (1978) discussed the terminology of the primary cell wall (P), and concluded the following; p. 78: "The term Primary Wall should be reserved for the first lamella of the cell wall." HARADA (1984) summarized the concepts for the fine structure of the wood cell wall. The primary wall (P) in the typically xylem elements consists of two parts, P-outer, P-inner. The microfibrillar orientation of the two parts is different. The S1 or S3 is designated as a "flat helix" the S2 as a "srep helix", although the S1 has a crossed fibrillar structure. SUGIYAMA, HARADA and SAIKI (1984) studied the crystalline ultrastructure of cellulose microfibrils by various electron microscopy techniques. It was established that the cellulose is damaged by electron beam, and the cellulose crystals are destroyed easily by the dose normally required to record lattice images.

Materials and Methods

The previously published two samples were the subject of our TEM study. Non-experimental and partially dissolved secondary wood fragments were ultrathin sectioned. The methods in detail see in the previous paper – KEDVES 1997, p. 57, 61. The lignit samples were postfixed in OsO_4 aqu. dil. and embedded in Araldite (Durcupan, Fluka). The ultrathin sections were made in the EM Laboratory of the Institute of Biophysics of the Biological Research Center of the Hungarian Academy of Sciences. The TEM pictures were taken on a Tesla BS-540 (resolution 6-7 Å).

Results

Sample no 1 (Plate 5.1., figs. 1,2, plate 5.2., figs. 1,2, plate 5.3.)
Sequoioxylon gypsaceum (GÖPPERT) GREGUSS 1967

Plate 5.1.

1,2. *Sequoioxylon gypsaceum* (GÖPPERT) GREGUSS 1967, non-experimental sample (T-9-1). Ultrastructure of the secondary wood remains.
1. Negative no: 6199, 50.000x.
2. Negative no: 6192, 50.000x.

Plate 5.2.

1,2. *Sequoioxylon gypsaceum* (GÖPPERT) GREGUSS 1967, TEM pictures of the partially dissolved lignite with diethylamine (T-9-2).
1. Negative no: 6436, 15.000x.
2. Negative no: 6440, 50.000x.

Plate 5.3.

Sequoioxylon gypsaceum (GÖPPERT) GREGUSS 1967. Ultrastructure of the partially dissolved lignit sample (T-9-3) with merkaptoethanol. Negative no: 6446, 10.000x.

Plate 5.4.

1-3. *Sequoioxylon medullare* GREGUSS 1967. TEM pictures from the non-experimental lignit sample (T-9-4).
1. Surface of the secondary wood. Negative no: 6629, 100.000x.
2. Inner part of the secondary woody remnant. Negative no: 6630, 100.000x.
3. Ultrastructure of the fossil resin. Negative no: 6162, 50.000x.

Plate 5.5.

1-4. *Sequoioxylon medullare* GREGUSS 1967, TEM pictures of the surface of the partially dissolved lignit sample (T-9-5) with diethylamine.
1. Negative no: 6633, 15.000x.
2. Negative no: 6634, 50.000x.
3. Negative no: 6635, 50.000x.
4. Negative no: 6635, 100.000x.

Plate 5.6.

1-3. *Sequoioxylon medullare* GREGUSS 1967. Ultrastructure of the lignit sample partially dissolved with merkaptoethanol (T-9-6).
1. Ultrastructure of the fossil resinous material in medullary ray cell. Negative no: 6673, 15.000x.
2. Ultrastructure of the partially dissolved secondary wood remnant. Negative no: 6474, 50.000x.
3. Ultrastructure of the surface of the partially dissolved secondary wood remnant. Negative no: 6474, 100.000x.

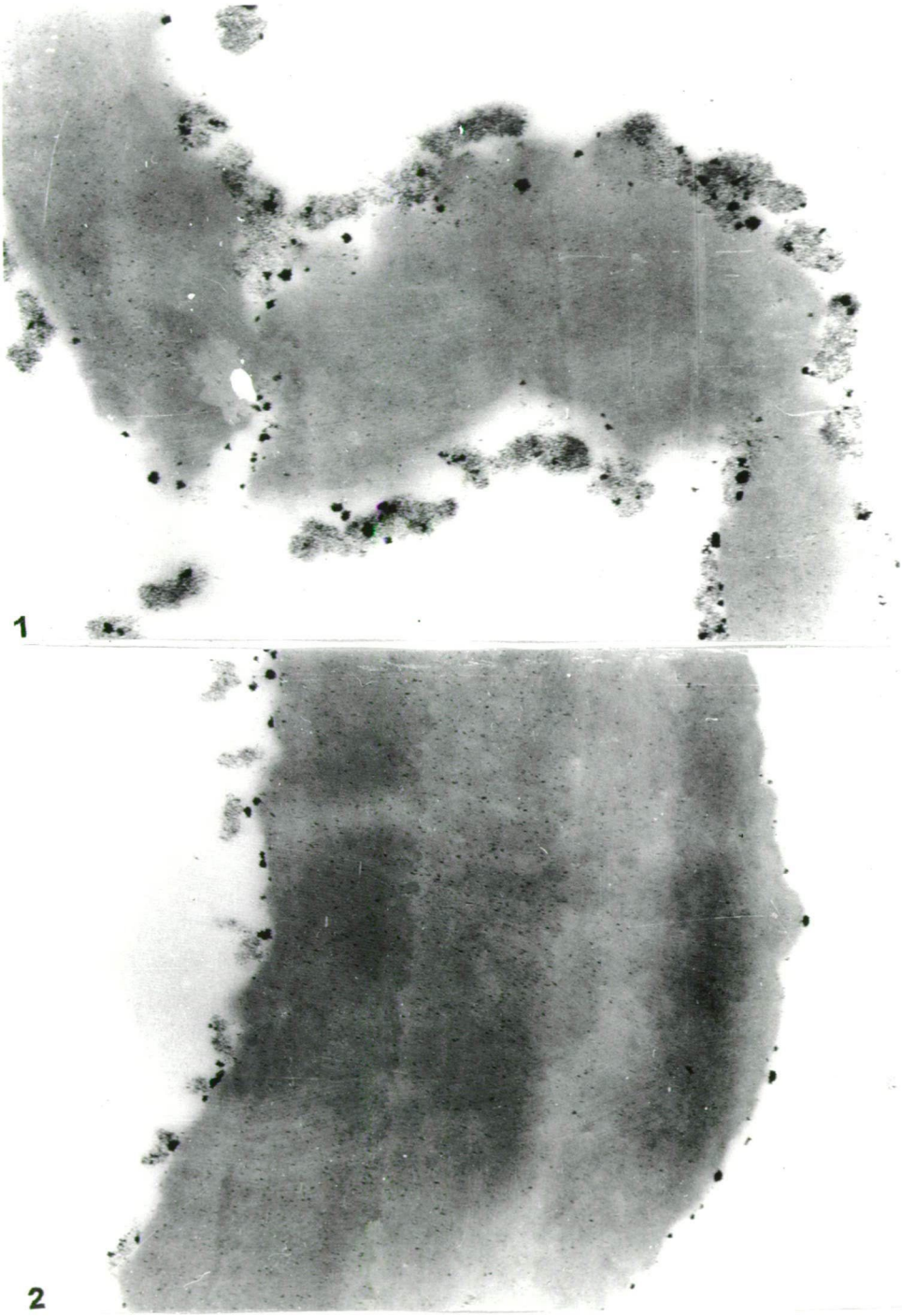

Plate 5.1.

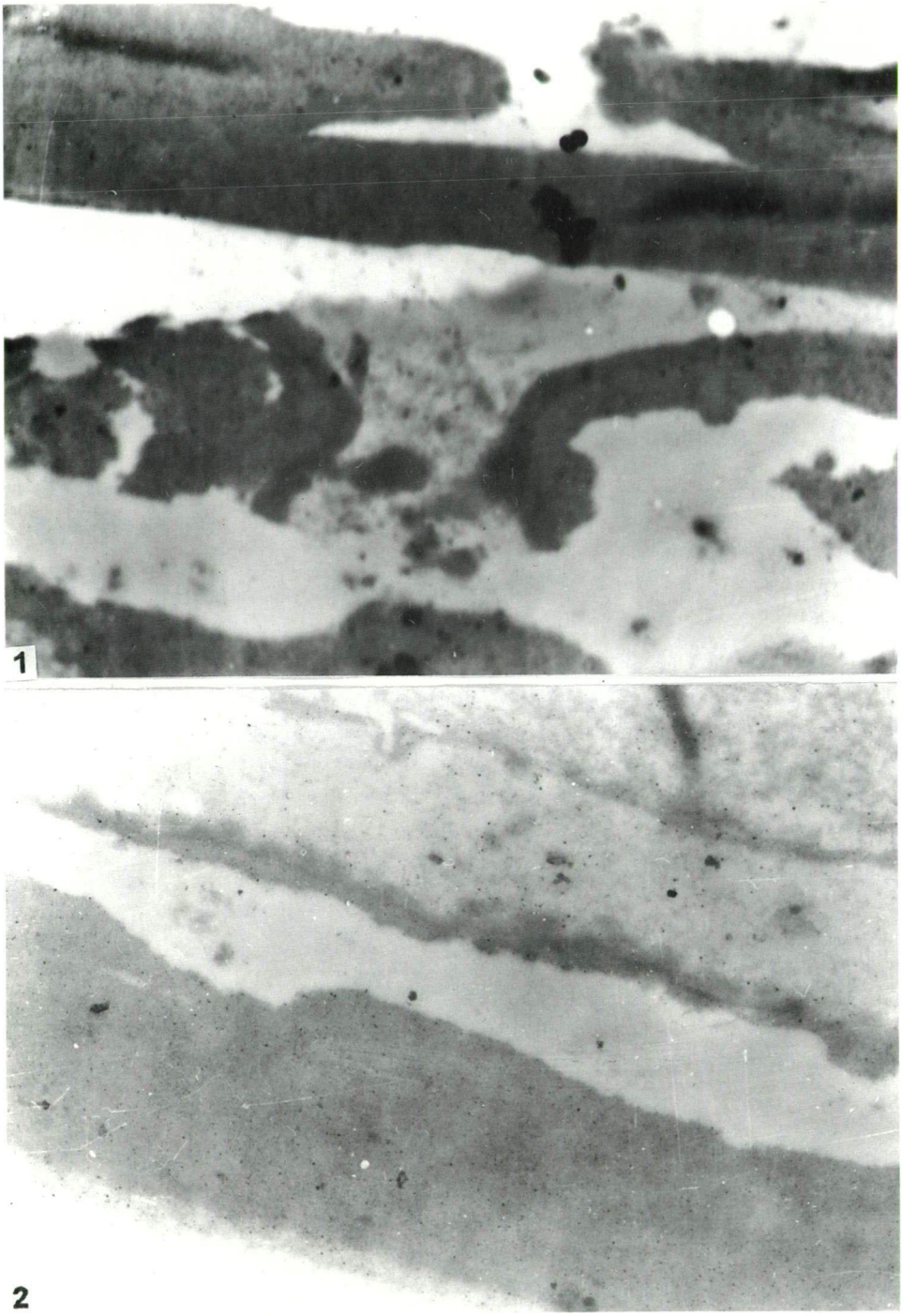

Plate 5.2.

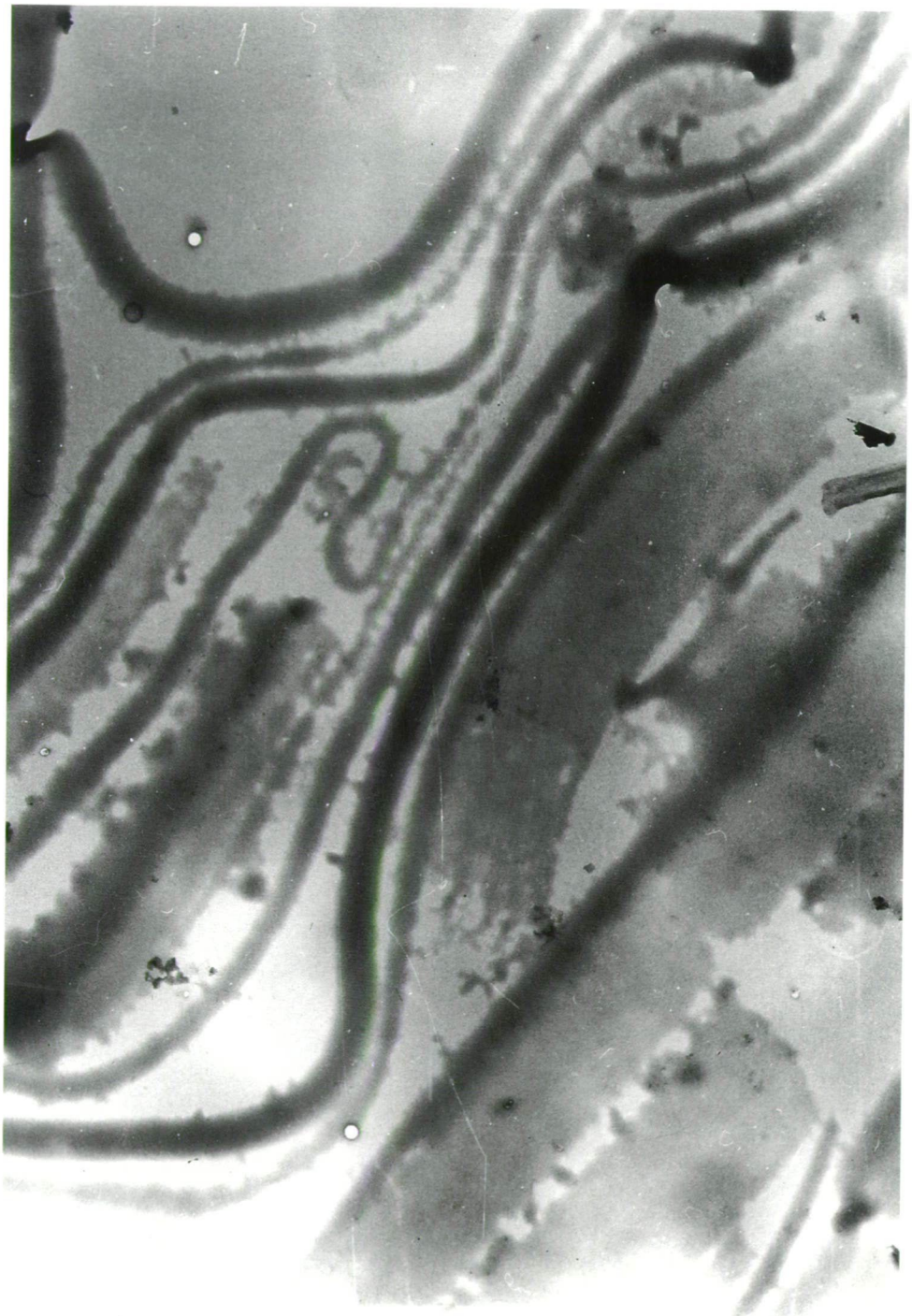

Plate 5.3.

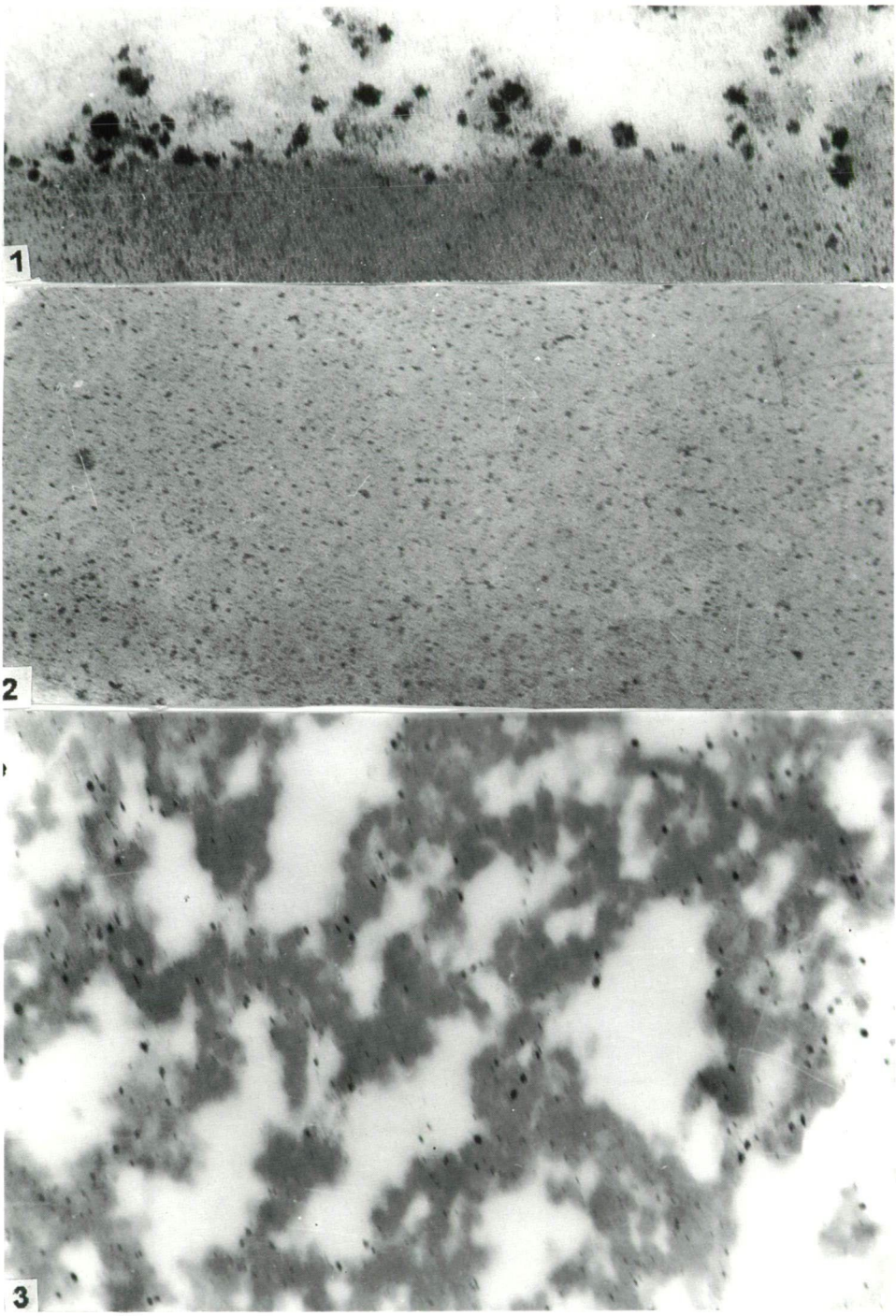

Plate 5.4.

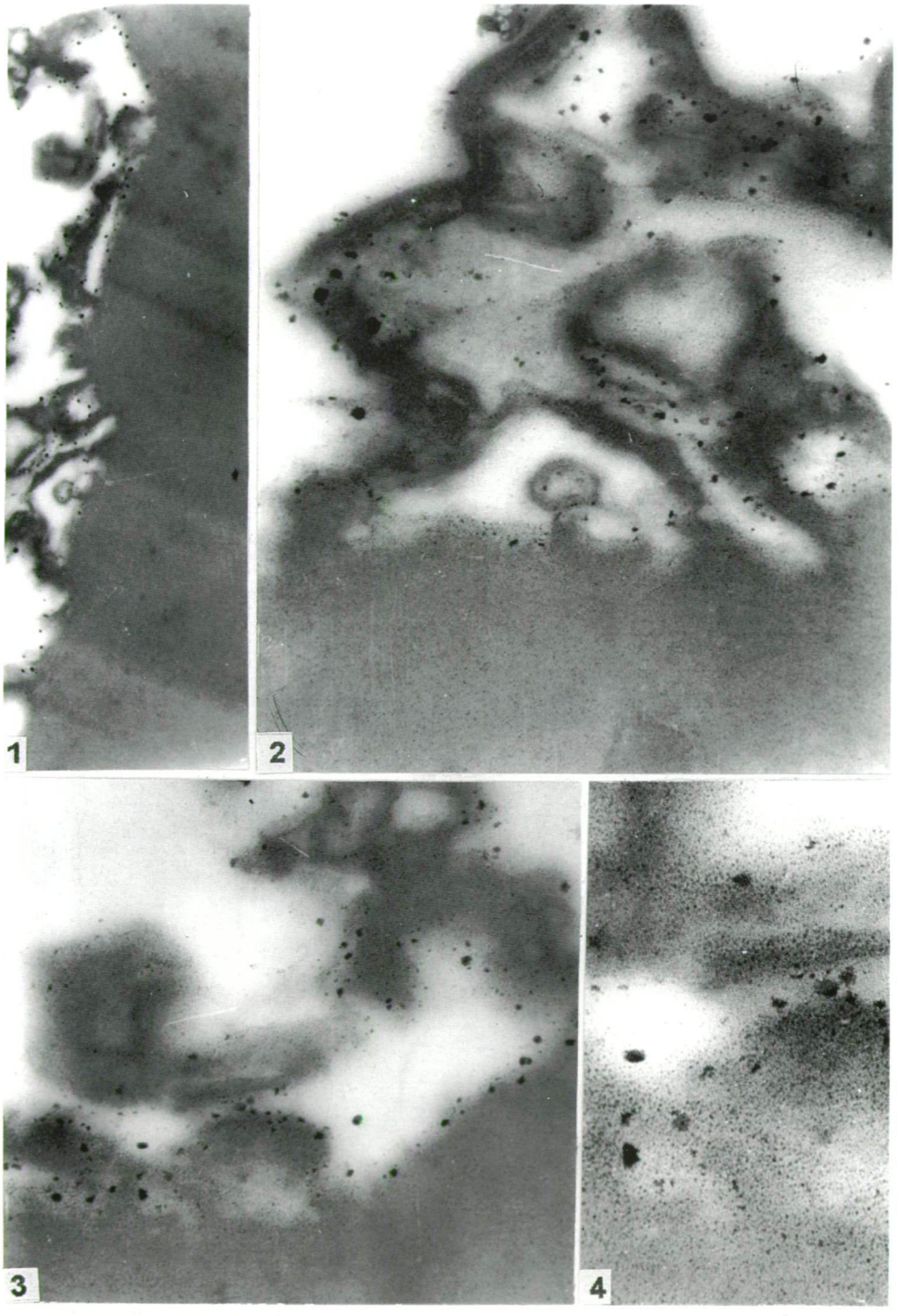

Plate 5.5.

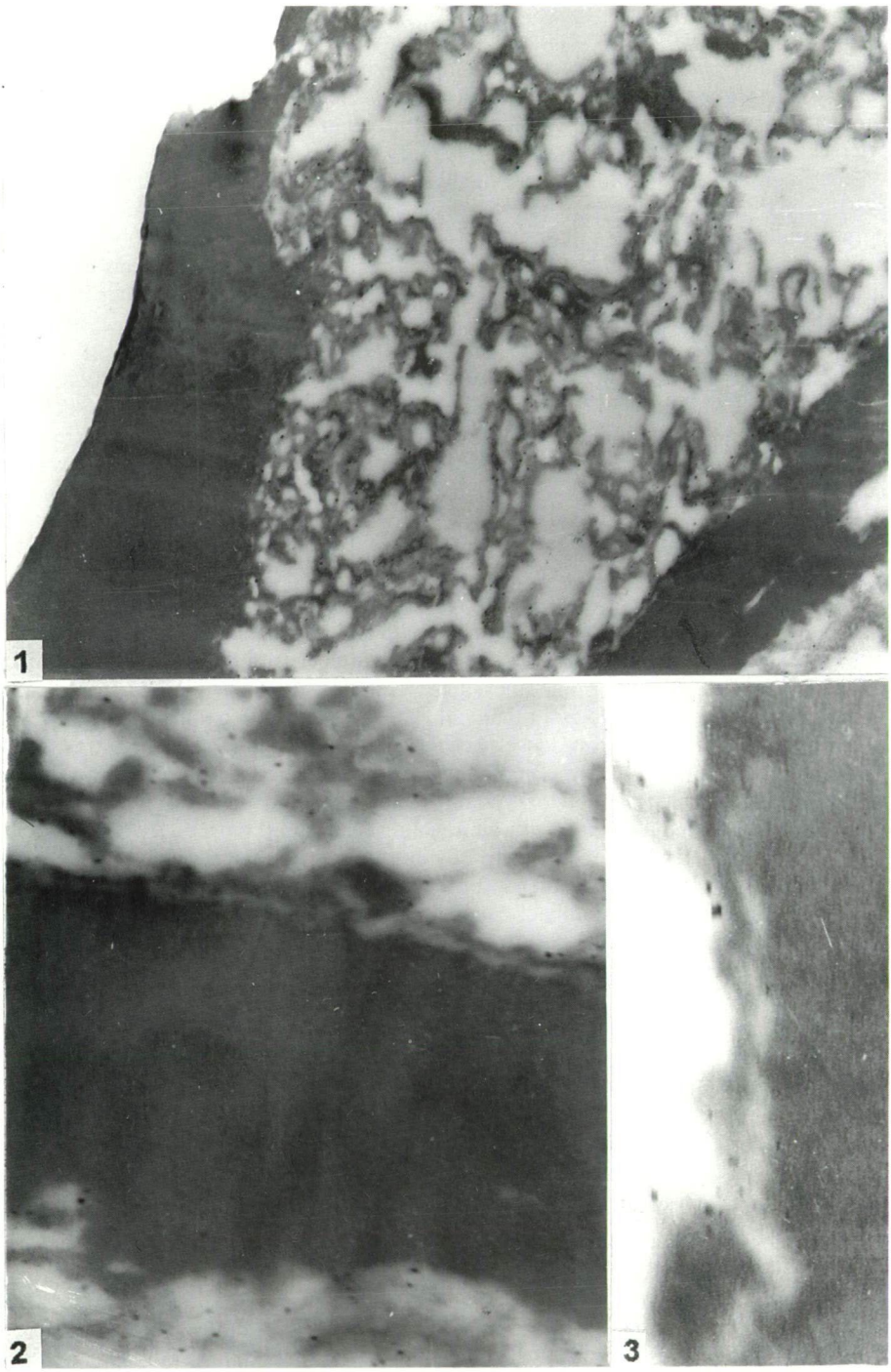

Plate 5.6.

The ultrastructure of the secondary wall of the non-experimental tracheids (Plate 5.1., figs. 1,2) is more or less homogeneous, but tiny granular elements are also present. Interesting alterations are on the surface. Extremely electron dense globular particles of different size are on the uneven surface. Finely granular particles are also on the surface or detached from the secondary wall.

Experiment T-9-2, dissolution with diethylamine during 30 days at 30 °C (Plate 5.2., figs. 1,2). After this experiment the electron dense particles, and the greatest part of the finely granular particles were dissoluted. No important alterations were observed at the secondary wall of the tracheids. On several parts of the tracheids, continuous in all probability secondary thin layer appeared on the surface. This layer is very clear in contrast to the secondary wall. Well shown on the lower part of picture 2 in Plate 5.2. Section of pits was also observed (Plate 5.2., fig. 1).

Experiment T-9-3, dissolution with merkaptoethanol during 30 days at 30 °C (Plate 5.3). The superficial electron dense particles dissolved. The outer part of the secondary wall is electron dense. In some parts of the ultrathin sections lamellar ultrastructure may be observed on the secondary wall. The detached lamellae of the secondary wall are electron dense.

Sample no 2 (Plate 5.4., figs. 1-3, plate 5.5., figs. 1-4, plate 5.6., figs. 1-3)
Sequoioxylon medullare GREGUSS 1967

The ultrastructure of the non-experimental tracheids (Plate 5.4., figs. 1-3). On the surface of the secondary wall of the tracheids there are electron dense particles of different size (Plate 5.4., fig. 1). Sometimes these granules are embedded in less electron dense particles which separate from the wall. The outer and the inner part of the secondary wall is full of tiny electron dense particles (Plate 5.4., figs. 1,2). The ultrastructure of the fossil resin (Plate 5.4., fig. 3) contains also tiny electron dense particles. The pattern of the resin has irregular network, composed of anastomosing drops.

Experiment T-9-5, dissolution with diethylamine during 30 days at 30 °C (Plate 5.5., figs. 1-4). The secondary wood seems to be more or less homogeneous without electron dense particles. The surface is interesting, different kind of lamellae and/or irregular particles separate from the compact secondary wall (Plate 5.5., 1-4). On the surface (Plate 5.5., fig. 3) in several places, there are tiny electron dense particles. These electron dense granular systems are present within the detached lamellae of the surface.

Experiment T-9-6, dissolution with merkaptoethanol during 30 days at 30 °C (Plate 5.6., figs. 1-3). After this kind of dissolution the wall of the secondary wood is more or less homogenous. (Plate 5.6., figs. 2,3). The outer lamellae on several part of the xylem remnant detached, well shown in pictures 2 and 3 in Plates 5.6. The ultrastructure of the resin remnant was observed in the ray cells (Plate 5.6., fig. 1). The fine structure of the resin is sometimes lamellar, but in general an irregular network.

Discussion and Conclusions

Based on our first TEM data of this research program of the Laboratory we can point out the following:

1. The peculiar submicroscopic pattern of the fossil resin was the same at the non-experimental and at the partially dissolved material.

2. The fossilization process results in remarkable alterations in the ultrastructure of the lignit samples. To this problem we need the results of further investigations within this program.

3. To investigate the microfibrillar structure of the fossil wall the partial dissolution with merkaptoethanol was the most successful.

Acknowledgements

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6. X-RAY EFFECT ON THE LM MORPHOLOGY OF SOME GYMNOSPERM AND ANGIOSPERM POLLEN GRAINS

M. KEDVES and Á. KÁROSSY

Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J. A. University, H-6701, P. O. Box 993, Szeged, Hungary

Abstract

Pollen grains of the following species were the subjects of the present contribution: *Pinus sylvestris* L., *Ranunculus acris* L., *Castanea sativa* MILL., and *Erica herbacea* L. Based on our results, the pollen grains of *Pinus sylvestris*, and *Erica herbacea* are very resistant to the X-ray irradiation. Not so characteristic pollen tube development in high quantity (71.0%) was observed at *Castanea sativa*. At *Ranunculus acris* in 39.0 per cent we have observed partial or complete pollen tube development after CuKα irradiation during 35 s.

Key words: Palynology, X-ray effect, light microscopy.

Introduction

The investigated material of this contribution is heterogeneous from taxonomical and pollen morphological point of view. Saccate *gymnosperm, angiosperm* tetrad, and pollen grains of early types of *angiosperm* from the *Ranunculaceae*, and *Fagaceae*, were the subject of this experimental study. Previously *Pinus* and *Castanea* pollen grains were investigated with the partial dissolution method within this research program. Results of the irradiated peculiar *gymnosperm* pollen grains (*Welwitschia mirabilis*) were the subject of another paper (KEDVES and PÁRDUTZ, 1997). At this species partial pollen tube development was observed.

Materials and Methods

Data of the investigated pollen grains are as follows:

Pinus sylvestris L.

Locality: Botanical Garden of the J. A. University. Collected: Dr. I. SZÖLLŐSI, on 25.05.1995. Irradiation: on the 25.05.1995, LM investigation: on the 25.05.1995.

Plate 6.1

1,2. *Pinus sylvestris* L. Recent. Experiment No: 1/7-127.
3-9. *Ranunculus acris* L. Recent. Experiment No: 1/7-181.
10-12. *Castanea sativa* MILL. Recent. Experiment No: 1/7-250.
13-16. *Erica herbacea* L. (*E. carnea* L.). Recent. Experiment No: 1/7-179.

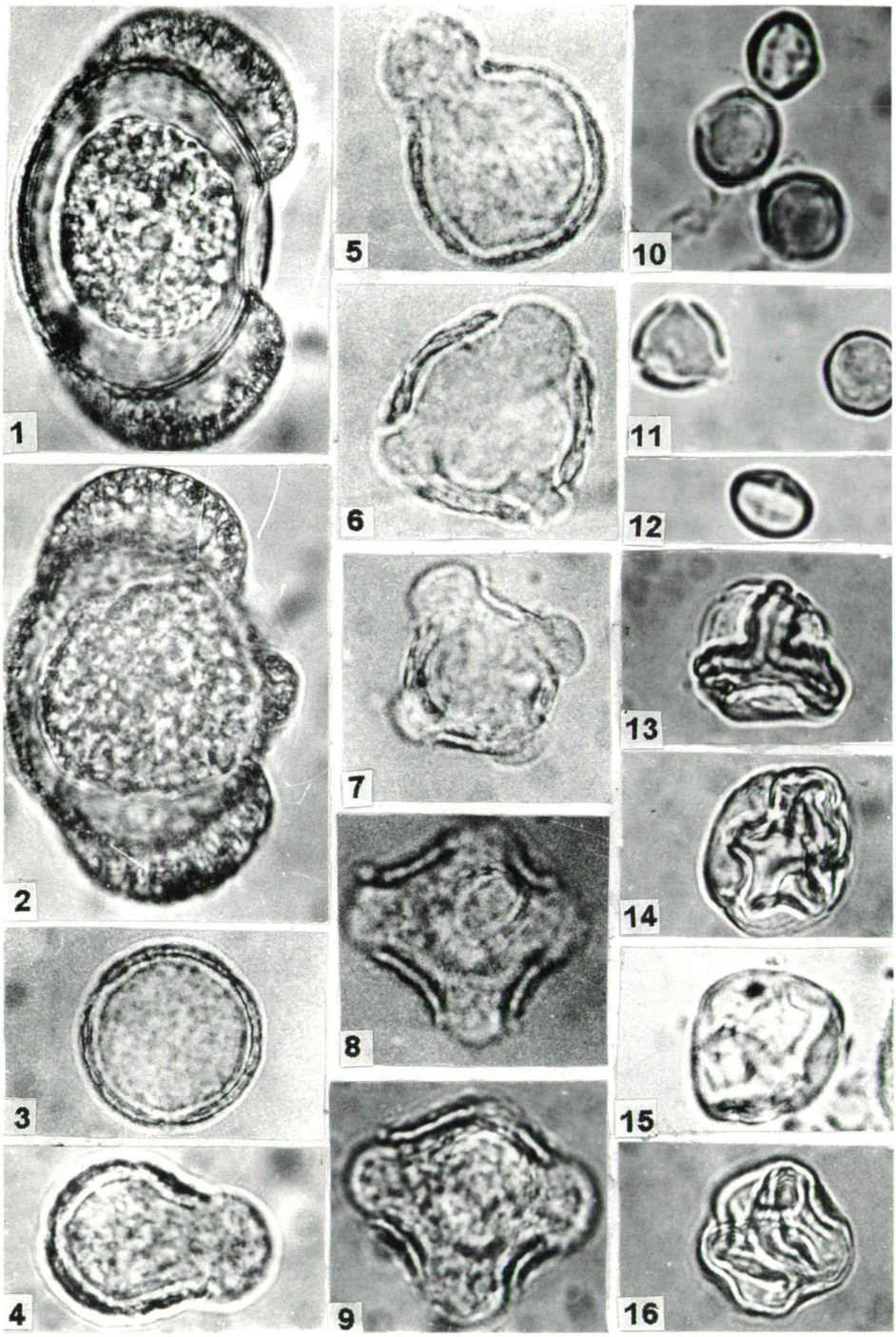

Plate 6.1.

Ranunculus acris L.

Locality: Botanical Garden of the J. A. University. Collected: Á. KÁROSSY on 01.06.1995. Irradiation: on the 01.06.1995, LM investigation: on the 04.06.1995.

Castanea sativa MILL.

Locality: Botanical Garden of the J. A. University. Collected: I. GÁSPÁR, on 12.06.1995. Irradiation: on the 13.06.1995, LM investigation: on the 30.06.1995.

Erica herbacea L.

Locality: Botanical Garden of the J. A. University. Collected: Á. KÁROSSY, on the 01.06.1995. Irradiation: on the 01.06.1995. LM investigation: on the 05.06.1995.

Length of irradiations: 35 s. Radiation data: 35 KV, 20 mA, CuKα beam. The irradiations were made with a BRON-OM1 apparatus in the Radiological Laboratory of the Department of Mineralogy, Petrography and Geochemistry of the J. A. University, Szeged.

Results

Pinus sylvestris L. (Plate 6.1., figs. 1,2)

This species is very resistant to X-ray irradiation. Not so characteristic pollen tube development was observed at 1.5 per cent of the investigated pollen grains (Plate 6.1., fig. 2). At the greatest part of the pollen grains (98.5%) the LM morphology of the pollen grains have not altered (Plate 6.1., fig. 1).

Ranunculus acris L. (Plate 6.1., figs. 3-9)

61.0% of the pollen grains have not altered after irradiation (Plate 6.1., fig. 3.). Total pollen tube development at 16.5% (Plate 6.1., figs. 6-9), partial one at 22.5% (Plate 6.1., figs. 4,5) of the investigated pollen grains.

Castanea sativa MILL. (Plate 6.1., figs. 10-12)

Partial, and not so characteristic pollen tube development was observed at 71.0% of the irradiated pollen grains (Plate 6.1., figs. 10,11). The quantity of the non-altered pollen grains is relatively low (29.0%), (Plate 6.1., fig. 12).

Erica herbacea L. (Plate 6.1., figs. 13-16)

The greatest part (88.0%) of the irradiated pollen grains have not altered (Plate 6.1., figs. 13,14,16). At 12 per cent not clearly perceptible pollen tube development was observed (Plate 6.1., fig. 15).

Discussion and Conclusions

The pollen grains of the saccate *gymnosperm* pollen grains are important in our research program, because quasi-crystalloid biopolymer structure was observed for the first time at *Pinus griffithii* MCCLELL (KEDVES, 1988). During our investigation of the high temperature effect, the alterations were also moderate (KEDVES, HEGEDŰS and OLÁH, 1992). Based on the TEM results of the irradiated pollen grains of *Pinus griffithii* (KEDVES, PÁRDUTZ and TÓTH, 1998) the resistance of the sporopollenin was emphasized.

The alterations in the LM morphology of the irradiated pollen grains of *Ranunculus acris* are typical. *Castanea sativa* is interesting because its very tiny pollen tube development.

The resistance of the pollen tetrads of *Erica herbacea* is also worth of mentioning. It seems that in general the experimental study of the tetrads needs detailed investigations in the future.

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7. X-RAY EFFECT ON THE ULTRASTRUCTURE OF THE POLLEN GRAINS OF SALIX ALBA L.

M. KEDVES[1], Á. PÁRDUTZ[2] and A. TÓTH[1]

1. Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J. A. University, H-6701, P. O. Box 993, Szeged, Hungary, 2. Institute of Biophysics, Biological Research Center of the Hungarian Academy of Sciences, H-6701, P. O. Box 521, Szeged, Hungary

Abstract

Pollen grains of *Salix alba* L. were irradiated with CuKα X-ray at 35 KV, 20 mA during 5 s., 15 s., 35 s., and 60 s. and investigated with transmission electron microscope. The ectexine and the endexine are very resistant, but important alterations were observed in the ultrastructure of the intine and the protoplasm.

Key words: Palynology, recent, *Salix alba*, X-ray effect, TEM.

Introduction

The reticulate *Longaxones* pollen grains represent one of the early stages in the evolution of the *angiosperms*. In this respect the *Platanaceae* and *Hamamelidaceae* were pointed out concerning the evolution of the early *angiosperm* pollen grains. (KEDVES, 1998). The global regional distribution of the tricolpate, tricolporate reticulate pollen grains during the Lower Cretaceous was summarized by KREMP (1978).

The early pollen morphological characteristic features and the evolutionary significance was the reason that we have chosen a species of *Salix* for experimental studies.

Materials and Methods

The investigation material was collected by Mr. I. GÁSPÁR on the 20th April, 1993. Locality: The left bank of the river Tisza. The irradiations were made on the 04.08.1993 in the Radiological Laboratory of the Department of Mineralogy, Petrology and Geochemistry of the J. A. University, Szeged, with a BRON-OM1 apparatus. Radiation data: 35 KV, 20 mA, CuKα X-ray. Length of time and numbers of the experiments: 5 s., 1746, 15 s., 1747, 35 s., 1748, 60 s., 1749. The irradiated pollen material was post-fixed with 1.0% OsO_4 aq. dil., and embedded in Araldite (Durcupan, Fluka). The ultrathin sections were made in the EM Laboratory of the Institute of Biophysics of the Hungarian Academy of Sciences, Biological Research Center on a Porter Blum ultramicrotome. The TEM photographs were made on an Opton EM-902 (resolution 2-3 Å), and on a Tesla BS-540 (resolution 6-7 Å). All pictures are unretouched.

Plate 7.1.

Salix alba L., Recent., Experiment No: 1746, general survey picture of the irradiated pollen grain. Negative no: 6074, 8.000x.

Plate 7.2.

1-5. *Salix alba* L., Recent. Experiment No: 1746.
1. Ultrastructure in the apertural area. Negative no: 6075, 15.000x.
2-4. Detail of the exine ultrastructure in the inter-apertural area.
2. Negative no: 6078, 50.000x.
3. Negative no: 6070, 50.000x.
4. Negative no: 6079, 50.000x.
5. Detail of the exine in the apertural area. Negative no: 6071, 50.000x.

Plate 7.3.

1-6. *Salix alba*. L. Recent. Experiment No: 1747.
1,2. General survey pictures of the irradiated pollen grain.
1. Negative no: 6110, 5.000x.
2. Negative no: 6095, 5.000x.
3,4. Ultrastructure in the apertural area.
3. Negative no: 6099, 50.000x.
4. Negative no: 6105, 15.000x.
5,6. Detail of the exine ultrastructure in the inter-apertural area.
5. Negative no: 6100, 50.000x.
6. Negative no: 6101, 50.000x.

Plate 7.4.

1-3. *Salix alba* L. Recent. Experiment No: 1748.
1. General survey picture of the irradiated pollen grain. Negative no: 6130, 5.000x.
2,3. Ultrastructure in the apertural area.
2. Negative no: 6131, 15.000x.
3. Negative no: 6129, 50.000x.

Plate 7.5.

1-3. *Salix alba* L. Recent.
1. Experiment No: 1748. Exine ultrastructure in the border of the apertural area. Negative no: 6127.
2,3. Experiment No: 1749.
2. Detail of the exine ultrastructure in the inter-apertural area. Negative no: 6086, 50.000x.
3. Exine ultrastructure in the apertural area. Negative no: 6084, 50.000x.

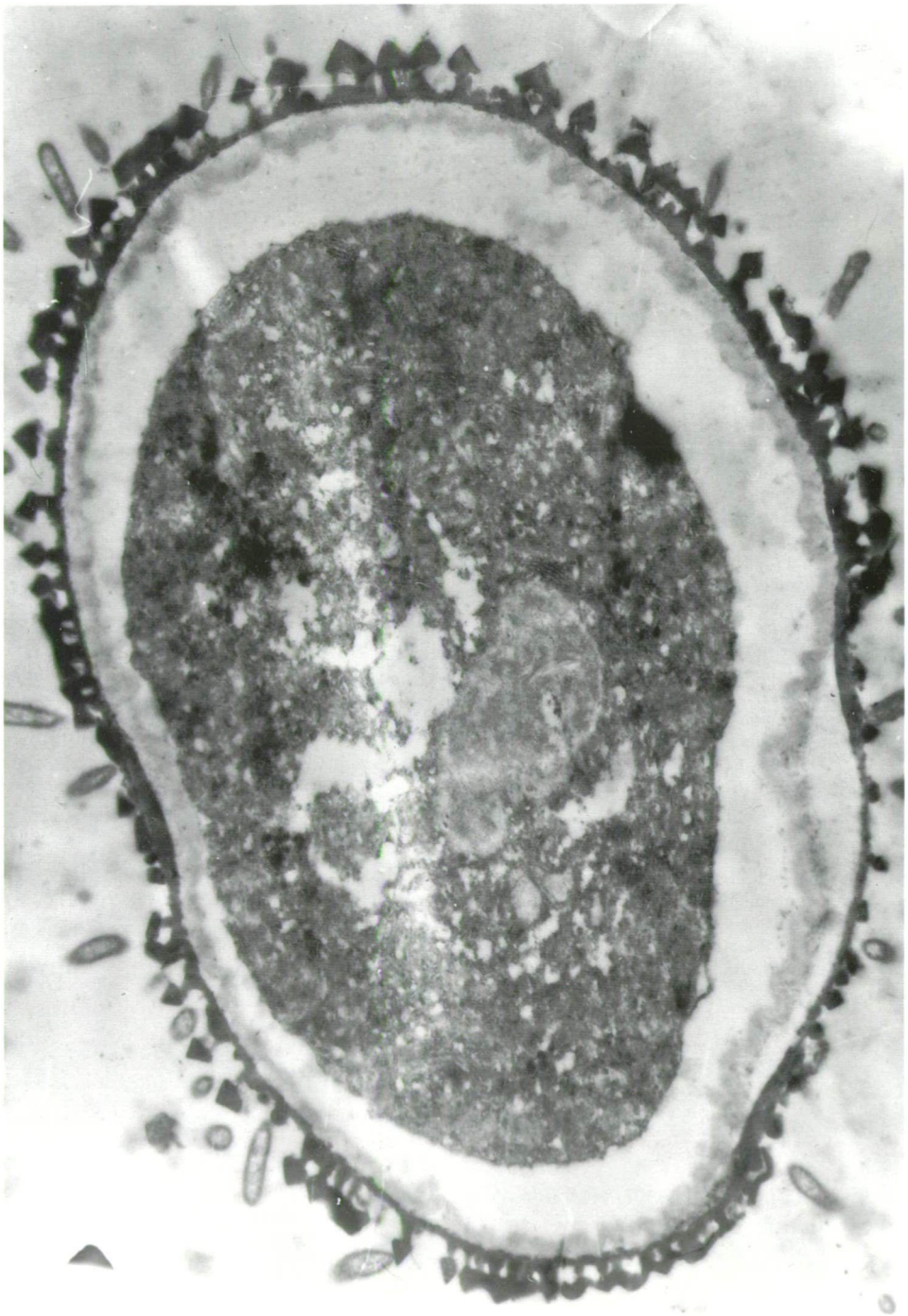


Plate 7.1.

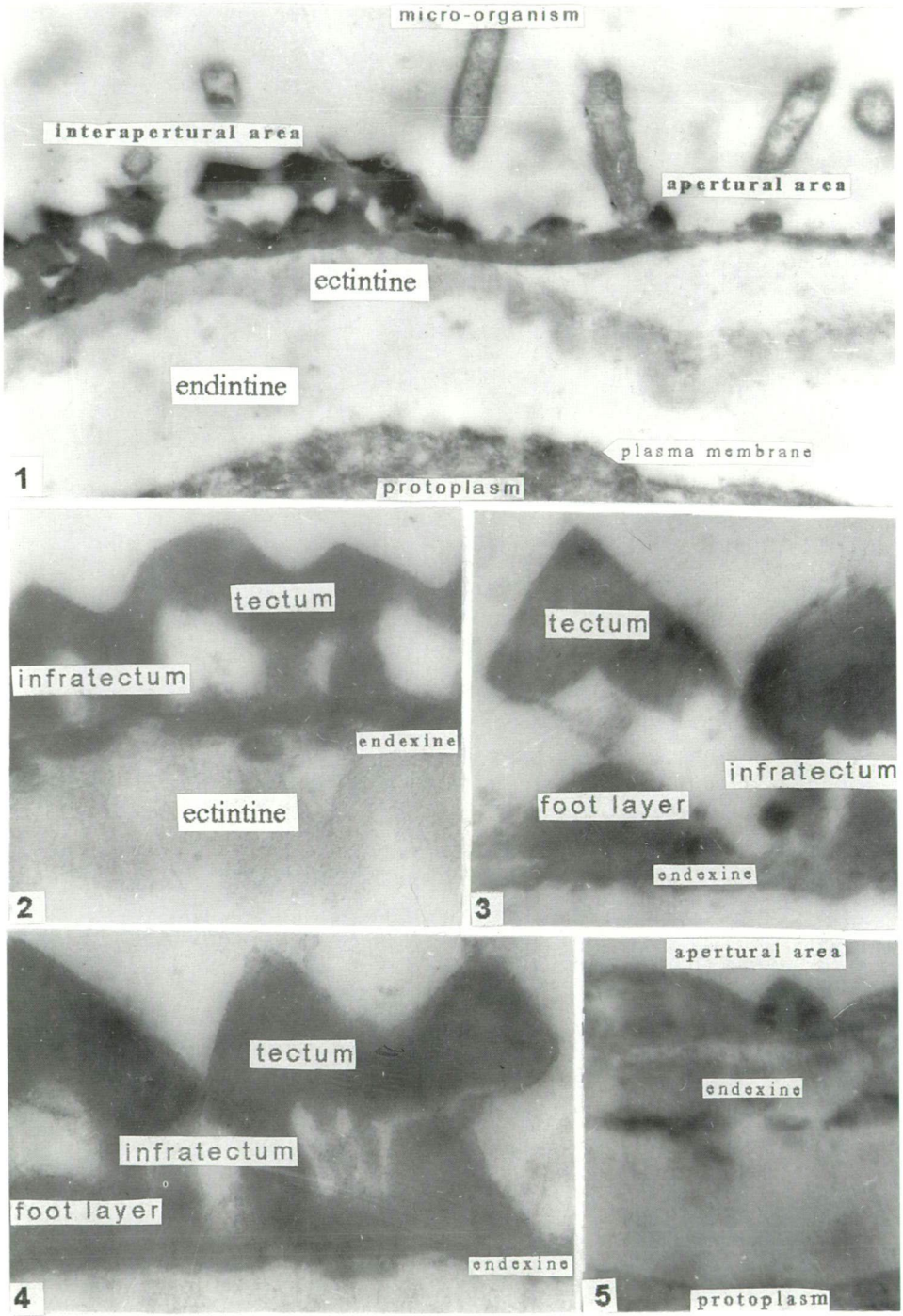
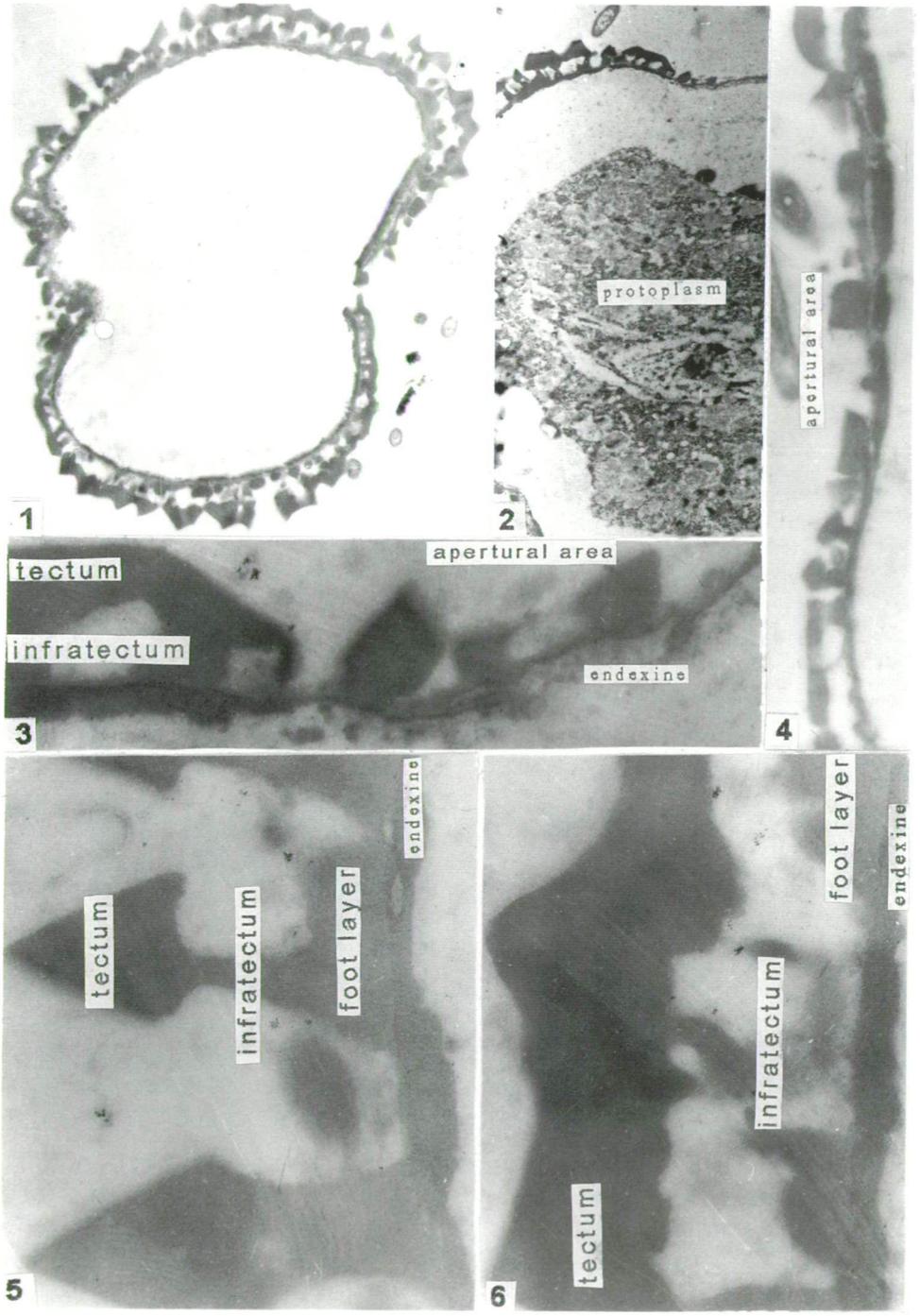

micro-organism
interapertural area
apertural area
ectintine
endintine
plasma membrane
protoplasm
1
tectum
infratectum
endexine
ectintine
2
tectum
infratectum
foot layer
endexine
3
tectum
infratectum
foot layer
endexine
4
apertural area
endexine
protoplasm
5

Plate 7.2.


1
2
protoplasm
apertural area
tectum
infratectum
apertural area
endexine
3
4
5
tectum
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foot layer
endexine
6
tectum
infratectum
foot layer
endexine

Plate 7.3.

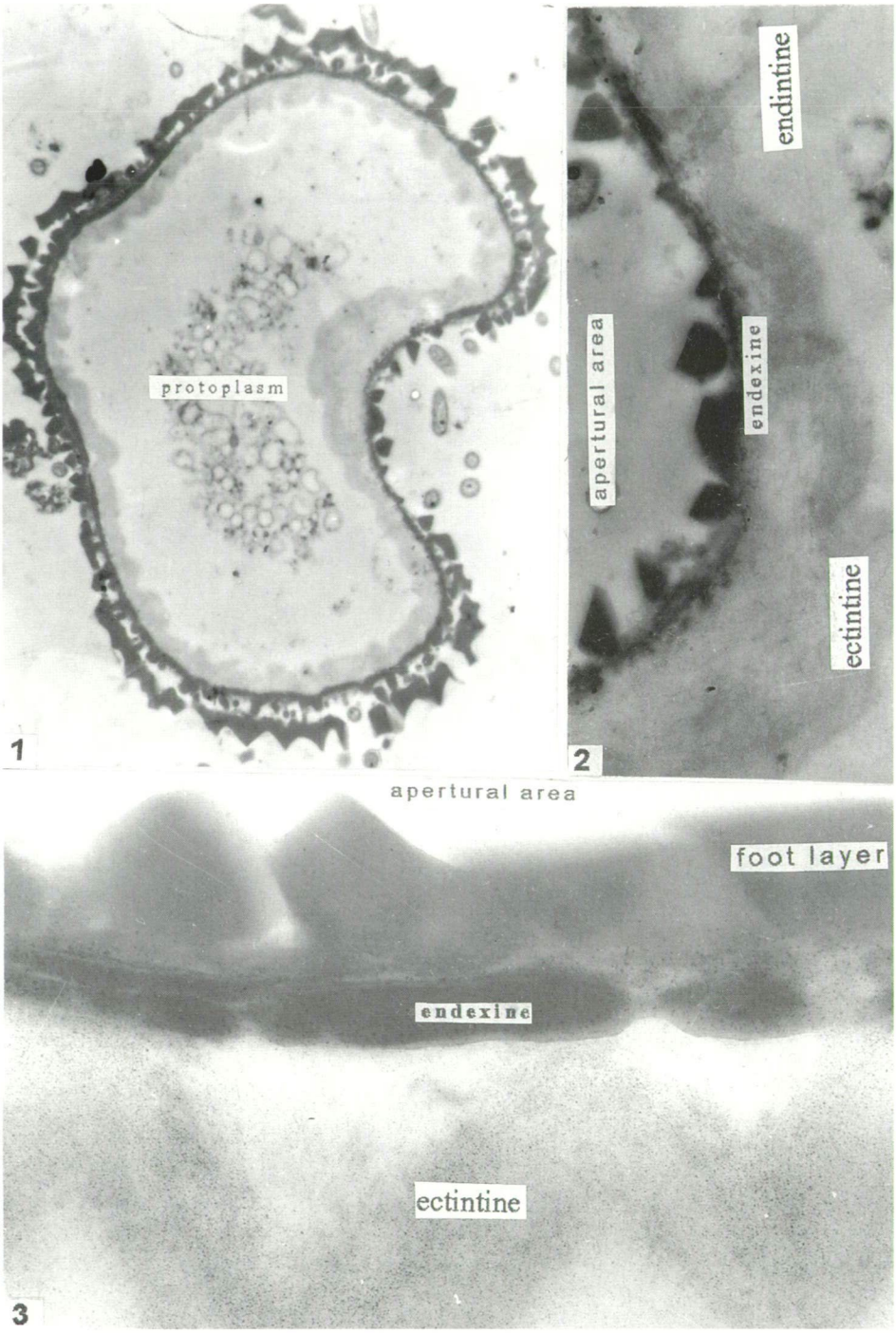
protoplasm
1
endintine
apertural area
endexine
ectintine
2
apertural area
foot layer
endexine
ectintine
3

Plate 7.4.

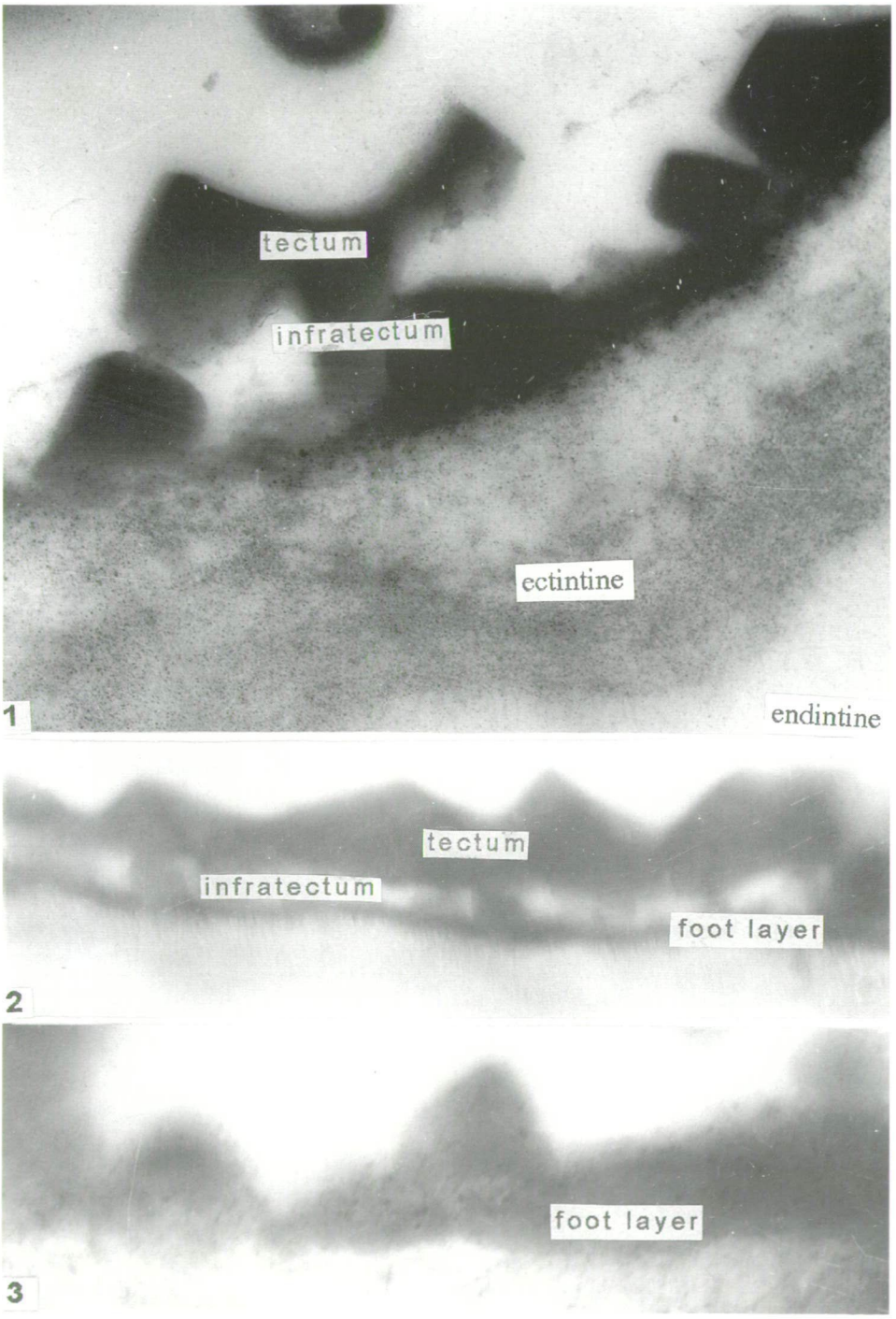
tectum
infratectum
ectintine
1
endintine
tectum
infratectum
foot layer
2
foot layer
3

Plate 7.5.

Results

Experiment No: 1746 (Plate 7.1., 7.2., figs. 1-5). – On the general survey TEM picture of the pollen grain (Plate 7.4) the following facts illustrated: 1. There are in all probability different kinds of micro-organisms on the surface. The ectexine is tectate perforate, infratectal layer columellar. At this, relatively low magnification, the endexine is not discernible. The intine is swelled, the two layers ectintine and endintine are characteristics. The electron density of the ectintine is stronger than of the endintine. The ectintine in consequence of the irradiation separate from the ectexine. This separation is more characteristic in the apertural area than in the non-apertural region. The plasma membrane is perceptible, sometimes separates also from the inner part of the protoplasm. At higher magnifications (Plate 7.2., figs. 1-5) the substance of the ectexine is homogeneous. The thin endexine is perceptible: in general this layer is more electron dense than the foot layer, sometimes discontinous (Plate 7.2., figs. 2-4). In the apertural area the ectexine is reduced to the foot layer and small remnants of the infratectal elements (Plate 7.2., figs. 1,5). The endexine is more fragmented here than in the inter-apertural area (Plate 7.1., fig. 5).

Experiment No: 1747 (Plate 7.3., figs. 1-6). – Essentially the TEM structure is identical to the previous experiment. The fine structure of the endexine is very characteristic in the inter-apertural (Plate 7.3., figs. 5,6) and in the apertural area (Plate 7.3., figs. 3,4). Worth of mentioning is that the ectintine is not well discernible as at the previous experiment, this is without doubt a methodical consequence.

Experiment No: 1748 (Plate 7.4., figs. 1-3, plate 7.5., fig. 1). – The intine swelled to a large measure, the ultrastructure of the protoplasm is disorganized (Plate 7.5., fig. 1). After this dose of irradiation some alterations were observed in the substance of the ectexine (Plate 7.5., fig. 1) namely large granules of stronger electron density appeared. Lamellar ultrastructure of the foot layer was observed in the apertural area (Plate 7.4., fig. 3). The measure of the fragmentation of the endexine is different in the apertural area to the inter-apertural region (Plate 7.4., figs. 2,3). The ectintine is well shown (Plate 7.4., figs. 1-3, plate 7.5., fig. 1), and finely granular, sometimes lamellar.

Experiment No: 1749 (Plate 7.5., figs. 2,3). – The substance of the ectexine is secondarily granular, particularly in the apertural area (Plate 7.5., fig. 3). Beneath the foot layer endexine was not observed. Probably in consequence of the degradation this is secondarily homogeneous. Degradation of the intine was also observed.

Discussion and Conclusions

At this species also the resistance of the ectexine to X-ray irradiation may be emphasized in comparison to the pollen grains of *Alnus glutionosa* (L.) GAERTN. (KEDVES and PÁRDUTZ, 1992). The fragmented endexine with its ultrastructural alterations by the irradiation dose is also interesting. The lamellar ultrastructure, which may together with the foot layer represent an early stage of the ontongeny, and in all respect of evolutionary point of view.

The ultrastructure of the intine and the alterations of this layer are also interesting. This layer was not investigated in detail at our experimental studies previously. The classical concepts of the stratification of the intine were summarized by TOMŠOVIC (1960) as follows:

Intina FRITZSCHE 1837 (the inner layer of the sporoderm which is composed of pectin and cellulose and is soluble by acids and alkalis).

Euintina KUPRIYANOVA 1955 = Endintine ELLIOTT 1951 (Where the intina is two-layered, there the inner layer consisting of cellulose fibrilla is impregnated with a pectinous matter).

Exintina FRITZSCHE 1837 (the outer layer of the two-layered intina is stronger than the euintina and is composed of pectin).

Recently IGERSHEIM (1997) investigated the different apertural intine protrusions in pollen grains of the *Rubiaceae*. Three variations have been distinguished by the different proportions of the two intine layers, the ect- and the endintine. Typically three-layered intine was described by LE THOMAS, SUÁREZ-CERVERA and GOLDBLATT (1997) from the pollen grains of the Afro-Madagascan genus *Aristea (Iridaceae, Nivenioideae)*. At two African species of the subtribe *Tragiinae (Euphorbiaceae)* also three-layered intine was established by the TEM investigations by SUÁREZ-CERVERA, GILLESPIE, FERNÁNDEZ-GONZÁLEZ and MÁRQUEZ (1997).

In conclusion it seems that the importance of the intine is greater than we believed earlier, and during our experimental studies it is important to investigate more circumstantially this layer, and the apertural protrusions.

Finally the pollen grains of *Salix* are allergenic, so in this respect the presence of the micro-organisms on the surface is important in this point of view. Combined allergenic effect may be presumed.

Acknowledgements

This research program was supported by the Grant OTKA 1/7 T 014692.

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8. LM INVESTIGATIONS OF PARTIALLY DISSOLVED SPOROMORPHS III.

M. KEDVES, E. HORVÁTH, A. BORBOLA and A. TÓTH

Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J.A. University, H - 6701, P.O. Box 993, Szeged, Hungary

Abstract

Pollen grains of the following species were partially dissolved: *Pinus sylvestris* L., *Magnolia kobus* DC., *Althaea rosea* (L.) CAV., *Alnus glutinosa* (L.) GÄRTN., *Zea mays* L. KSC 370 *saccharata* hybrid. The following organic solvents were used for partial dissolution: diethylamine, merkaptoethanol, methanol, ethanol, n-propanol, and i-amyl alcohol. Temperature: 30 °C, length of time: 30, 90, 150, 210, 270 and 330 days. The ectexine of the investigated species is relatively resistant. Complete dissolution was not observed during these experiments. No alterations were observed at the pollen grains of *Pinus sylvestris*, this corresponds to the previous experiments on the saccate *gymnosperm* pollen grains. Minor alterations were observed on the pollen grains of *Magnolia kobus* and *Alnus glutinosa*. Pollen grains of *Althaea rosea* are also resistant but diethylamine after 270 and 330 days dissolved the outer ornamental elements, the spinae. The most important alterations were observed on the pollen grains of *Zea mays saccharata* after dissolution in diethylamine and merkaptoethanol particular after 270 days.

Key words: Palynology, recent, pollen grains, partial dissolution, LM method.

Introduction

The aim and the problems of this kind of research program of our Laboratory were published previously (KEDVES, KÁROSSY and BORBOLA, 1997). Different pollen types of different taxonomical position were investigated with the same method (KEDVES et al., 1998). This contribution presents recent results within this research program.

Materials and Methods

Pollen grains of the following species were the subject of the present studies:

Pinus sylvestris L.

Locality: Botanical Garden of the J.A. University. Collected: Á. ERDŐDI on 09.05.1987. Beginning of the experiments: 12.05.1997. Numbers of experiments: 1/7 - 859-900.

Magnolia kobus DC.

Locality: Garden of the J.A. University. Collected: Á. ERDŐDI on 24.03.1997. Beginning of the experiments: 24.03.1997. Numbers of experiments: 1/7 - 761-802.

Althaea rosea (L.) CAV.

Locality: Left bank of the river Tisza., at Szeged. Collected: E. HORVÁTH on the 01.07.1997. Beginning of the experiments: 07.07.1997. Numbers of experiments: 1/7 - 930-977.

Plate 8.1., 1-42. *Pinus sylvestris* L.

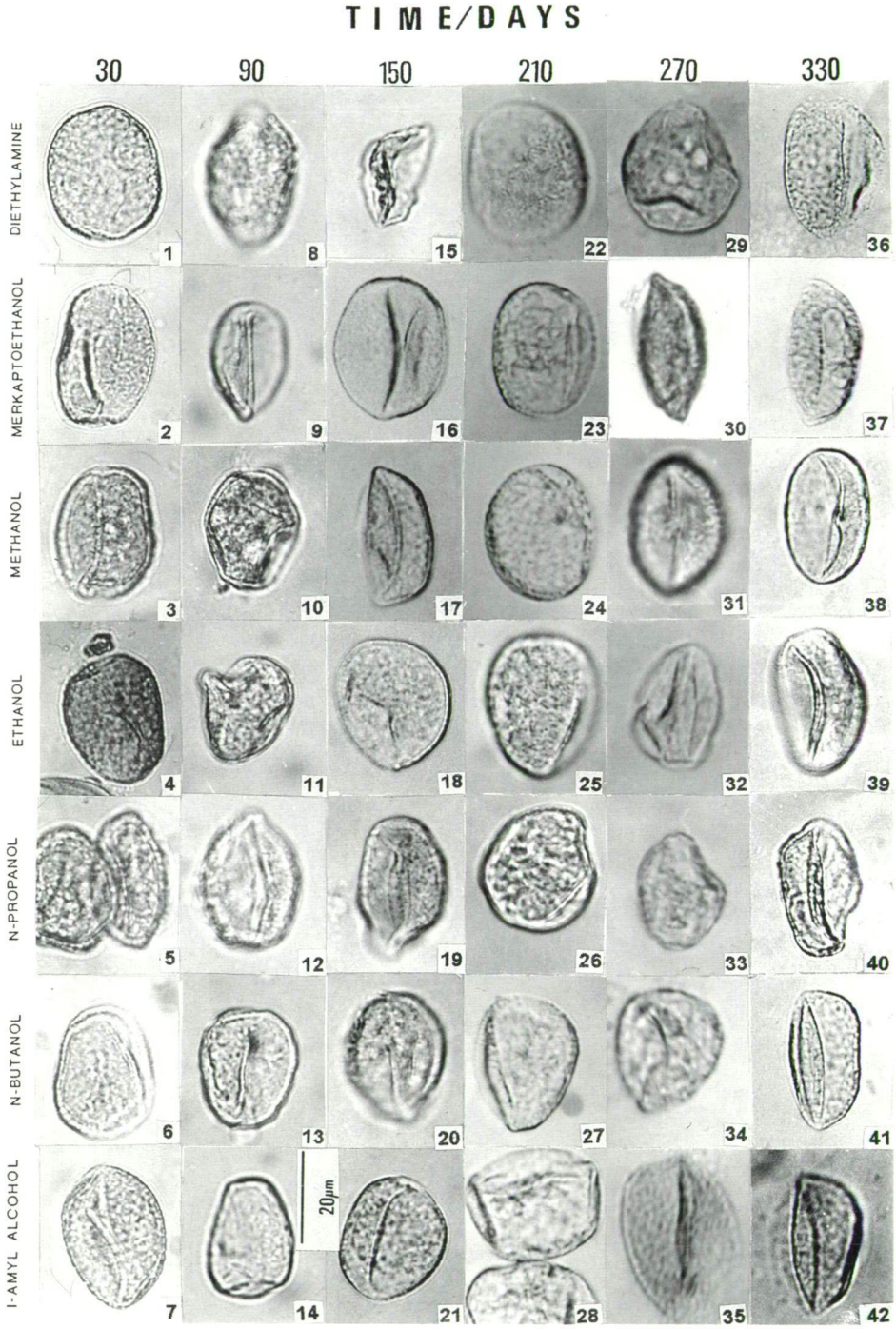

Plate 8.2., 1-42. *Magnolia kobus* DC.

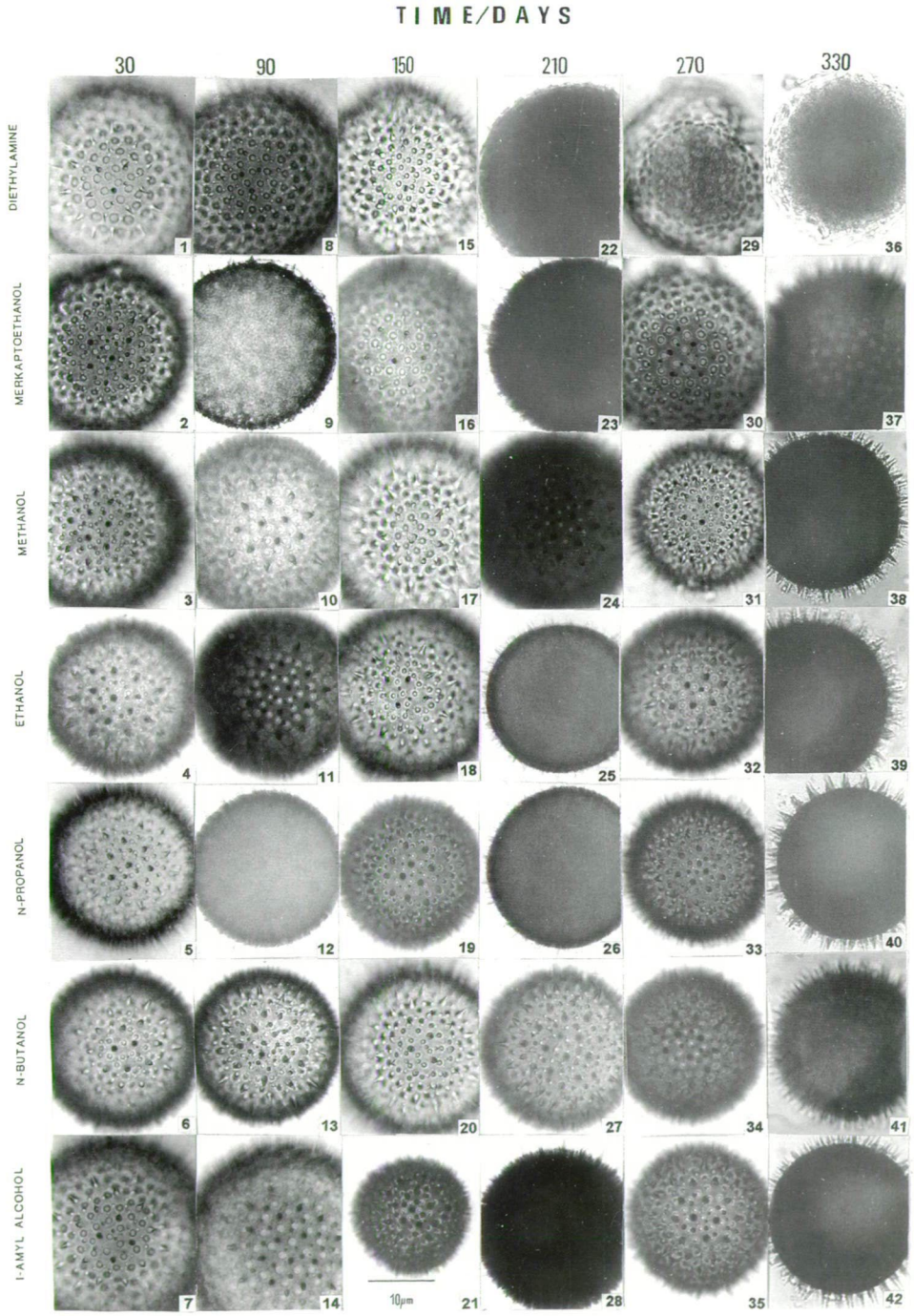

Plate 8.3., 1-42. *Althaea rosea* (L.) CAV.

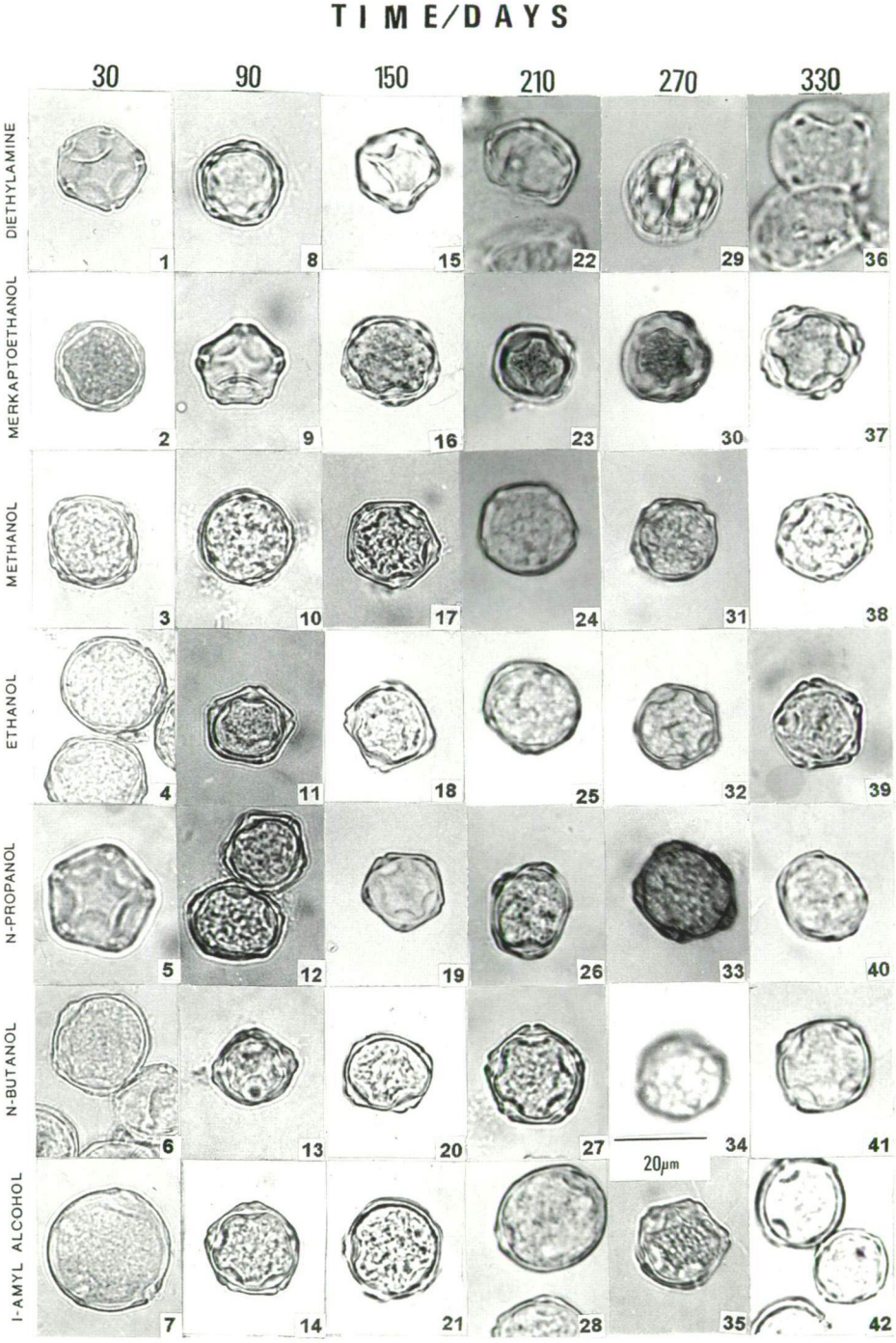

Plate 8.4., 1-42. *Alnus glutinosa* (L.) GÄRTN.

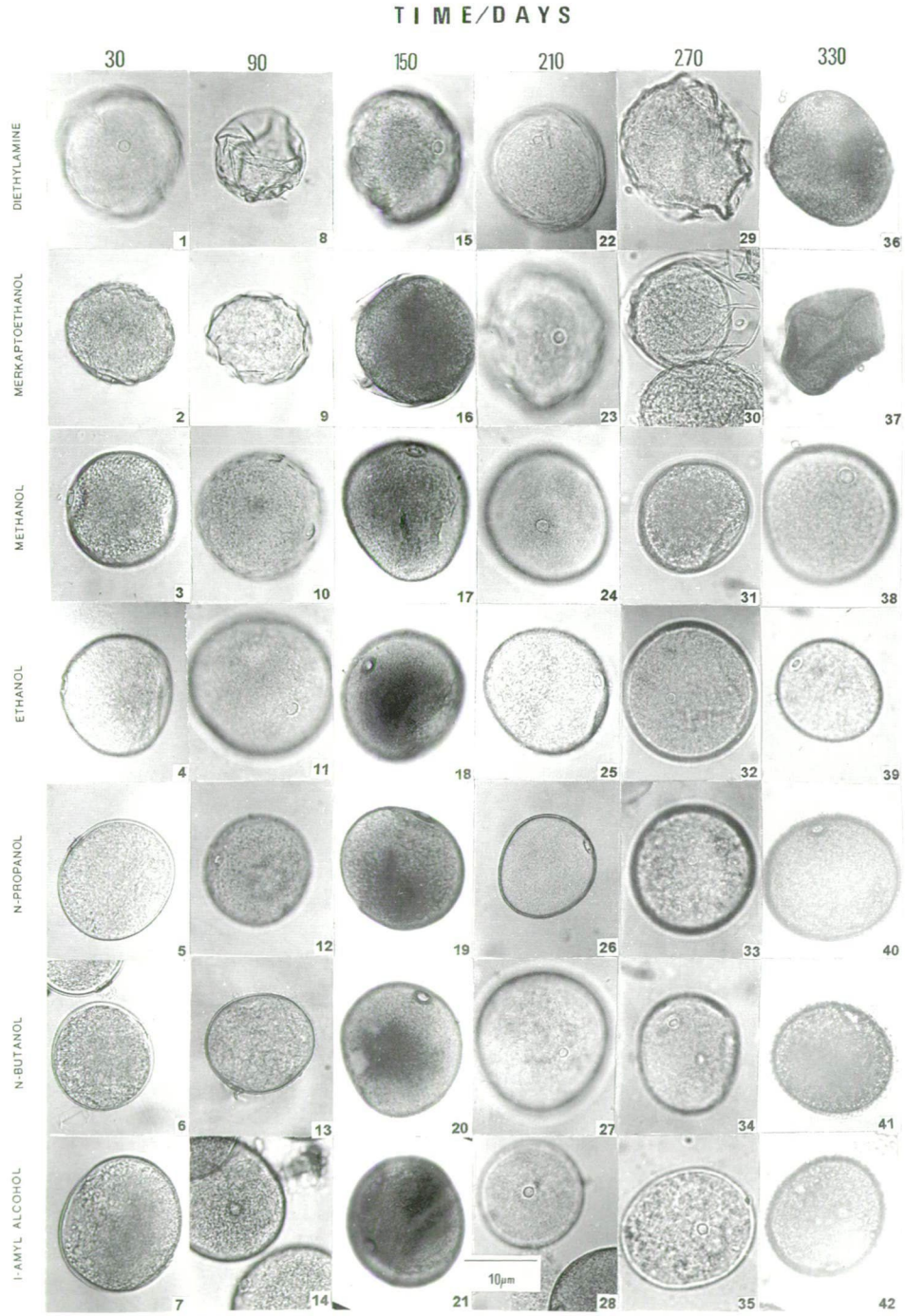

Plate 8.5., 1-42. *Zea mays* L. KSC 370 *saccharata* hybrid

Alnus glutinosa (L.) GÄRTN.

Locality: Botanical Garden of the J.A. University. Collected: Á. ERDŐDI on 07.03.1997. Beginning of the experiments: 12.03.1997. Numbers of experiments: 1/7 - 718-759.

Zea mays L. KSC 370 *saccharata* hybrid

Locality: Ságvári Experimental Research Station of the Cereal Research Institute. Collected: Dr. A. PALÁGYI on the 02.08.1997. Beginning of the experiments: 05.08.1997. Numbers of experiments: 1/7 - 988-1036.

The method of the partial dissolution is completely identical with the earlier, which was first described in our first paper (p. 45) and was repeated in the second part (p. 77). The solvents and the length of time of the partial dissolution are well shown in the Plates 8.1-8.5.

Results

Pinus sylvestris L. (Plate 8.1., figs. 1-42)

Pollen grains of this species are very resistant to the used solvents of this kind of experiment. Minor qualitative morphological alterations were observed in the apertural area, but these may not be considered significant.

Magnolia kobus DC. (Plate 8.2., figs. 1-42)

Minor qualitative morphological alterations were observed only, which may be the consequence of the so-called intraspecific morphological variation. Worth of mentioning is that after 330 days of experiments the original monosulcate form was observed.

Althaea rosea (L.) CAV. (Plate 8.3., figs. 1-42)

Important alterations in the LM morphology of this kind of interesting pollen grains were observed after partial dissolution with diethylamine. After dissolution of 30-150 days the diameter of the pores increased. From 210-330 days of dissolution the echinate sculptural elements disappeared. The alteration of the diameter of the pores appeared after the experiments with merkaptoethanol, and i-amyl alcohol.

Alnus glutinosa (L.) GÄRTN. (Plate 8.4., figs. 1-42)

Several kinds of morphological alterations were observed, the most characteristic ones are as follows: Diethylamine after 270 and 330 days damaged the pollen grains, the size increased and the ectexine structure seems also to be damaged. Alterations in the basic morphology of the apertural area were observed after dissolution with merkaptoethanol. This started after 150 days, and very characteristic at the end of this experiment (Plate 8.4., fig. 34). Alterations in the contour of the pollen grains were also observed for example figs. 7, 25, 28, 34 on the Plate 8.4.

Zea mays L. KSC 370 *saccharata* hybrid (Plate 8.5., figs. 1-42)

Important qualitative alterations were observed by the dissolution with diethylamine and merkaptoethanol. The ectexine altered, the outer layers fold out from the inner one. This started after 30 days of dissolution but particularly characteristic after 270 days.

Discussion and Conclusions

1. The molecular system of the sporopollenin of the pollen grains of the recently investigated species is quite resistant because complete dissolution was not observed.

To this see Plate 5.3. (*Platanus hybrida* BROT.) and 5.4. (*Tilia platyphyllos* SCOP.) in the paper of KEDVES et al., (1998).

2. Pollen grains of *Pinus sylvestris* were the most resistant within this series of experiments. But on the other hand it is interesting that from the partially degraded exine of *Pinus griffithii* first the quasi-crystalloid biopolymer system (KEDVES, 1987) was observed. Further experiments on saccate *gymnosperm* pollen grains resulted in very characteristic molecular structures (KEDVES, 1992).

3. Interesting and important is the resistant sporopollenin of the *Magnolia* pollen grains. Taking into consideration the evolutionary trends of the earliest *angiosperm* pollen grains (cf. DOYLE, 1977) the *Magnoliaceae* was very important in this point of view.

4. Pollen grains of the *Malvaceae* will be another program of research because of several reasons, for example the globular form, the polyporate exine, the peculiar ornamentation, and the superficial covering material. Important alterations in the LM morphology were observed only after a long time of partial dissolution with diethylamine and merkaptoethanol.

5. In comparison with *Betula verrucosa* EHRH. there are minor alterations at the pollen grains of *Alnus glutinosa*.

6. Finally the first data in this respect on the pollen grains of "*Gramineae* type" resulted in interesting alterations by dissolution with diethylamine and merkaptoethanol. These alterations suggest the necessity of the transmission electron microscope method also for these pollen grains.

Acknowledgements

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9. ULTRASTRUCTURE OF PARTIALLY DISSOLVED POLLEN GRAINS OF PLATANUS HYBRIDA BROT.

M. KEDVES[1], Á. PÁRDUTZ[2] and A. TÓTH[1]

1. Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J.A. University, H - 6701, P.O. Box 993, Szeged, Hungary 2. Institute of Biophysics, Biological Research Center of the Hungarian Academy of Sciences, H-6701, P. O. Box 521, Szeged, Hungary

Abstract

Fresh pollen grains of *Platanus hybrida* BROT. were partially dissolved with diluted glycerine of 50% and investigated with transmission electron microscope. The ultrastructure data are completely different from those of the dissolution experiment by the other previously used organic solvents. Particularly the well preserved organelles of the protoplasm are worth of mentioning, This is important because the recent and fossil pollen material in the laboratories are preserved in dilute glycerine with some antimicrobial products such as phenol aq. dil. or mercury-chlorure.

Key words: Palynology, experimental, ultrastructure, *Platanus hybrida.*

Introduction

During the last years we carried out several kinds of experiments to a better knowledge of the particularly interesting and difficult macromolecular system of the sporopollenin. The partial degradation processes and the solubility or resistance of the sporopollenin of the different taxa are important to understand the complexity of this problem.

Taking into consideration that for the preservation of the recent and fossil pollen grains the glycerine jelly is a quite generally used mounting medium, or the recent and fossil sporomorphs are mounted in glycerine with phenol or chloride of mercury we planned to use glycerine also as one of the organic solvents. This paper presents our first results in this subject.

Materials and Methods

The pollen grains were collected by Miss Á. ERDŐDI in the Botanical Garden of the J. A. University on 30.04.1996. The experiment (1/7-472) was the following: 5 ml glycerine (50%) was added to 5 mg fresh pollen grains. Temperature: 30 °C, length of time 30 days. The pollen material was washed with distilled water, then postfixed with 1.0% OsO4 aq. dil. and embedded in Araldite (Durcupan, Fluka). The ultrathin sections were made in the EM Laboratory of the Institute of Biophysics of the Hungarian Academy of Sciences. Biological Research Center on a Porter Blum ultramicrotome. The microphotographs were made on an Opton EM-902 (resolution 2-3 Å), and on a Tesla BS-540

(resolution 6-7 Å), For the basic works of the organelles of the protoplasms we used the handbooks as follows: HALL (1978), CSABA and MADARÁSZ (1981), KIMBALL (1984), AVERS (1985), DARNELL, LODDISH and BALTIMORE (1986).

Results

The general survey pictures (Plate 9.1., figs. 1,2) well illustrate the ultrastructure of the pollen grain. Tectate, perforated ectexine, infratectum columellar. Beneath the foot layer the intine is two layered, by its electron density. The plasma membrane and the organelles of the protoplasm also well shown. The nucleus and particularly in picture 1, of Plate 9.1. the fine structure of the nucleolus is well illustrated. In the protoplasm there are electron dense granules (microbodies), and lighter globular vacuoles.

Highly magnified pictures of the fine structure of the apertural area are well shown (Plate 9.2., fig. 1). Remnants of the infratectal layer are characteristic in the colpus area, and the inner endexious layer is also well shown. Different layers of the intine and the plasma membrane are characteristic. In picture 1, and 2, of Plate 9.2., the microbodies of the protoplasm are well illustrated. Plate 9.3., figs. 1,2, illustrate the fine structure of the protoplasm in particular of the nucleus. Well shown are the microbodies, mitochondrion, Golgi like vesicles. Beneath the nuclear envelope there are heterochromatin granules. Highly magnified picture from the nuclear envelope is illustrated in Plate 9.4., fig. 1. Picture 2 (Plate 9.4.) illustrates lamellae (tubuli) around the nucleus. These lamellae (tubuli) are illustrated in highly magnified picture in Plate 9.5.

Discussion and Conclusions

Taking into consideration the basic problem of the solvent effect of the glycerine, we need to emphasize the following:

1. The ultrastructure of the layers of the wall, have not altered. Ectexine and particularly the intine was in a good preservation.
2. The organelles of the protoplasm are also well preserved in contrast to the other solution experiments.
3. Finally the conservation of the pollen grains in diluted glycerine may be used as a good mounting medium.

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Plate 9.1.

1,2. *Platanus hybrida* BROT., Experiment No: 1/7-472, General survey picture of the ultrastructure of the pollen grain. Negative nos: picture 1: 6423, 5.000x, picture 2: 6427, 5.000x.

Plate 9.2.

1,2. *Platanus hybrida* BROT., Experiment No: 1/7-472.
1. Detail of the ultrastructure of the pollen grains in the apertural area. Negative no: 6429. 15.000x, mb: microbodies.
2. Ultrastructure of the pollen grain in the interapertural area. Negative no: 6426, 15.000x.

Plate 9.3.

1,2. *Platanus hybrida* BROT., Experiment No: 1/7-472.
1. General survey picture of the protoplasm of the pollen grain. Well shown are the heterochromatine granules beneath the nuclear envelope. Negative no: 6422, 5.000x.
2. Detail of the ultrastructure of the protoplasm. Negative no: 6423, 20.000x, ne: nuclear envelope, g: Golgi like vesicles, mb: microbodies, M: mitochrondrion.

Plate 9.4.

1,2. *Platanus hybrida* BROT., Experiment No: 1/7-472.
1. Detail of the nucleus of the pollen grain. Negative no: 6723, 100.000x, ne: nuclear envelope.
2. Detail of the ultrastructure of the pollen grain. Illustrated are the lamellae (tubuli) around the nucleus. Negative no: 5811, 100.000x.

Plate 9.5.

Platanus hybrida BROT., Experiment No: 472, detail of the nucleus and the cytoplasm and the lamellae (tubuli) around the nucleus. Negative no: 5811, 300.000x.

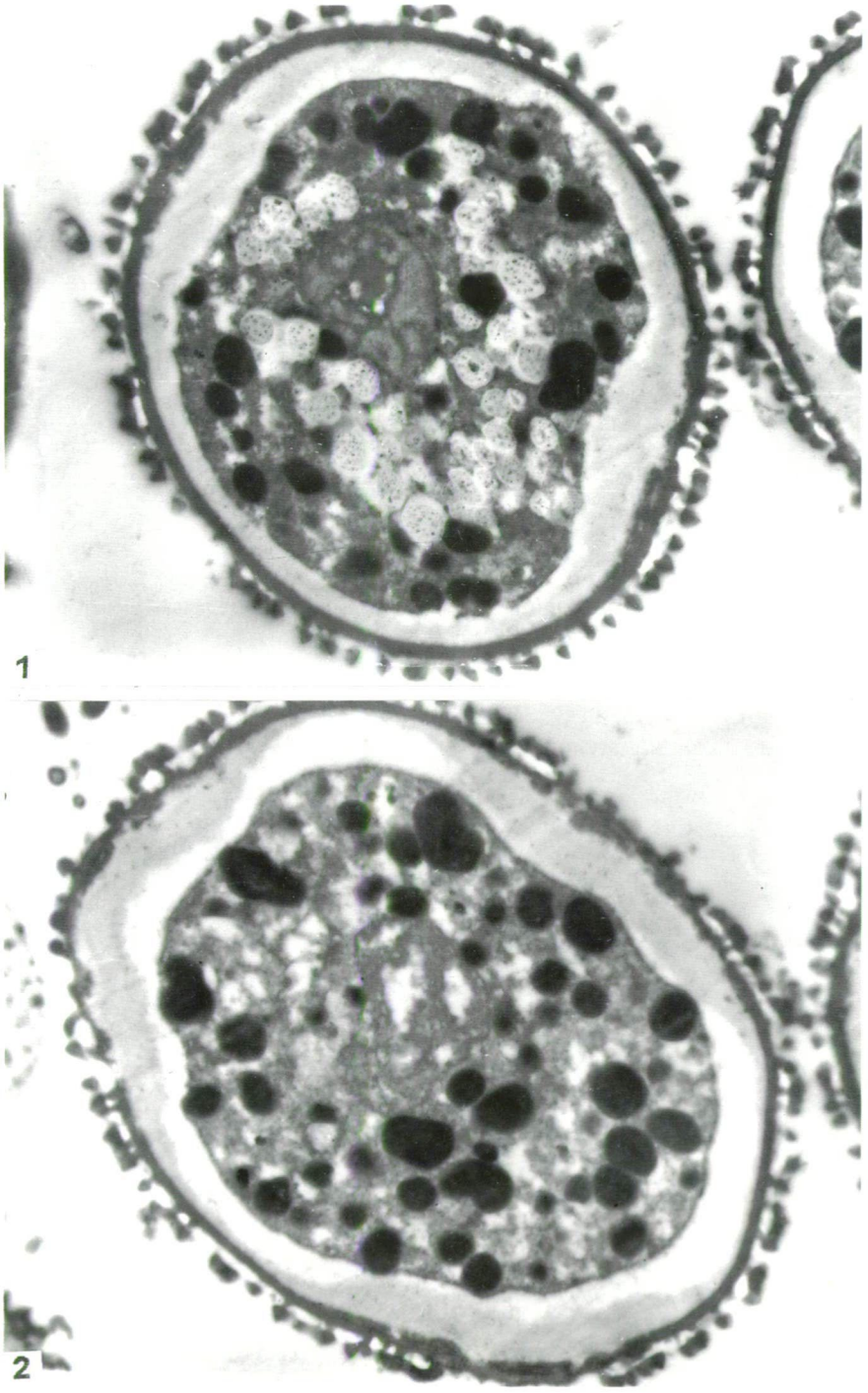

Plate 9.1.

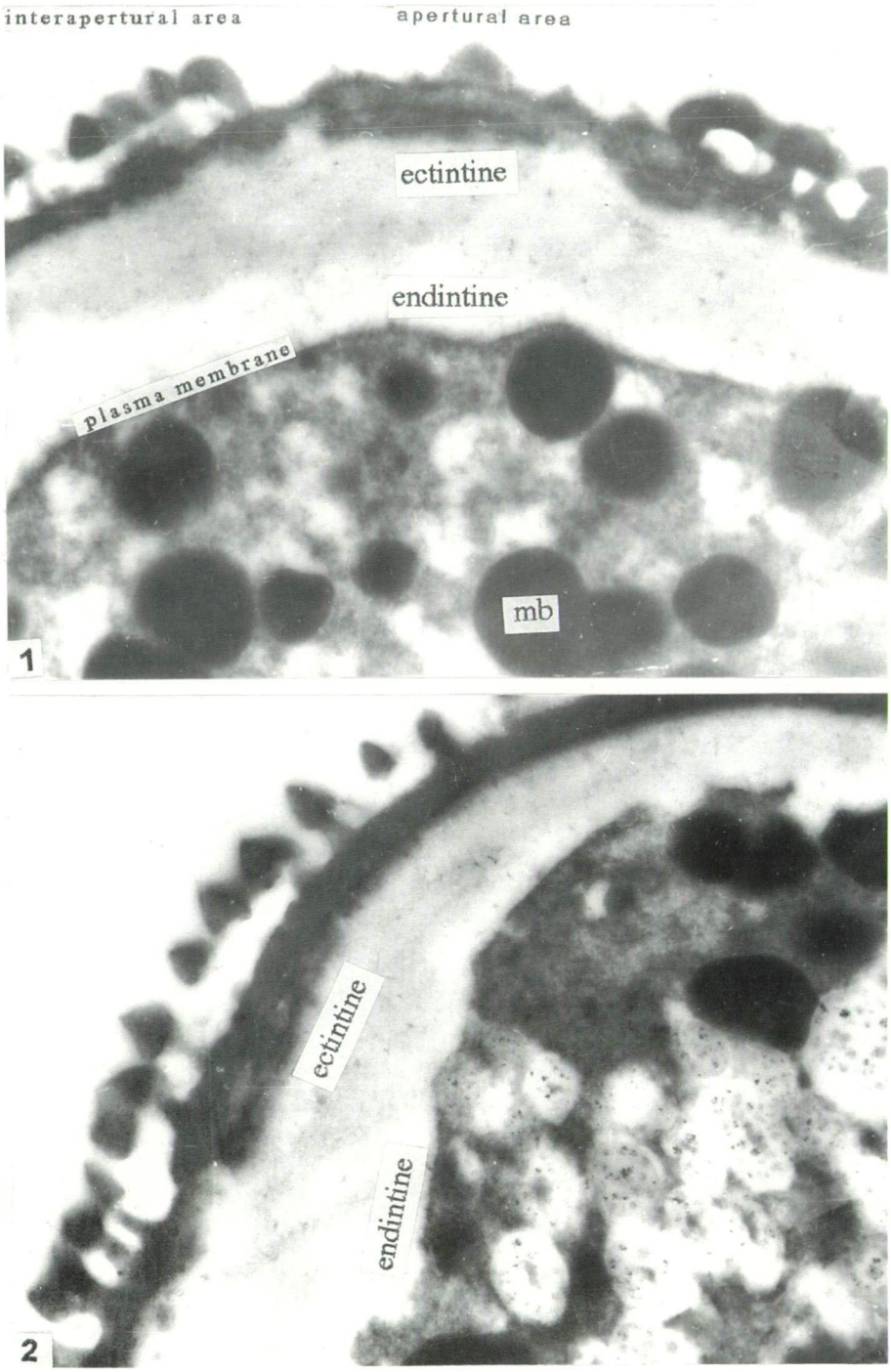
interapertural area
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Plate 9.2.

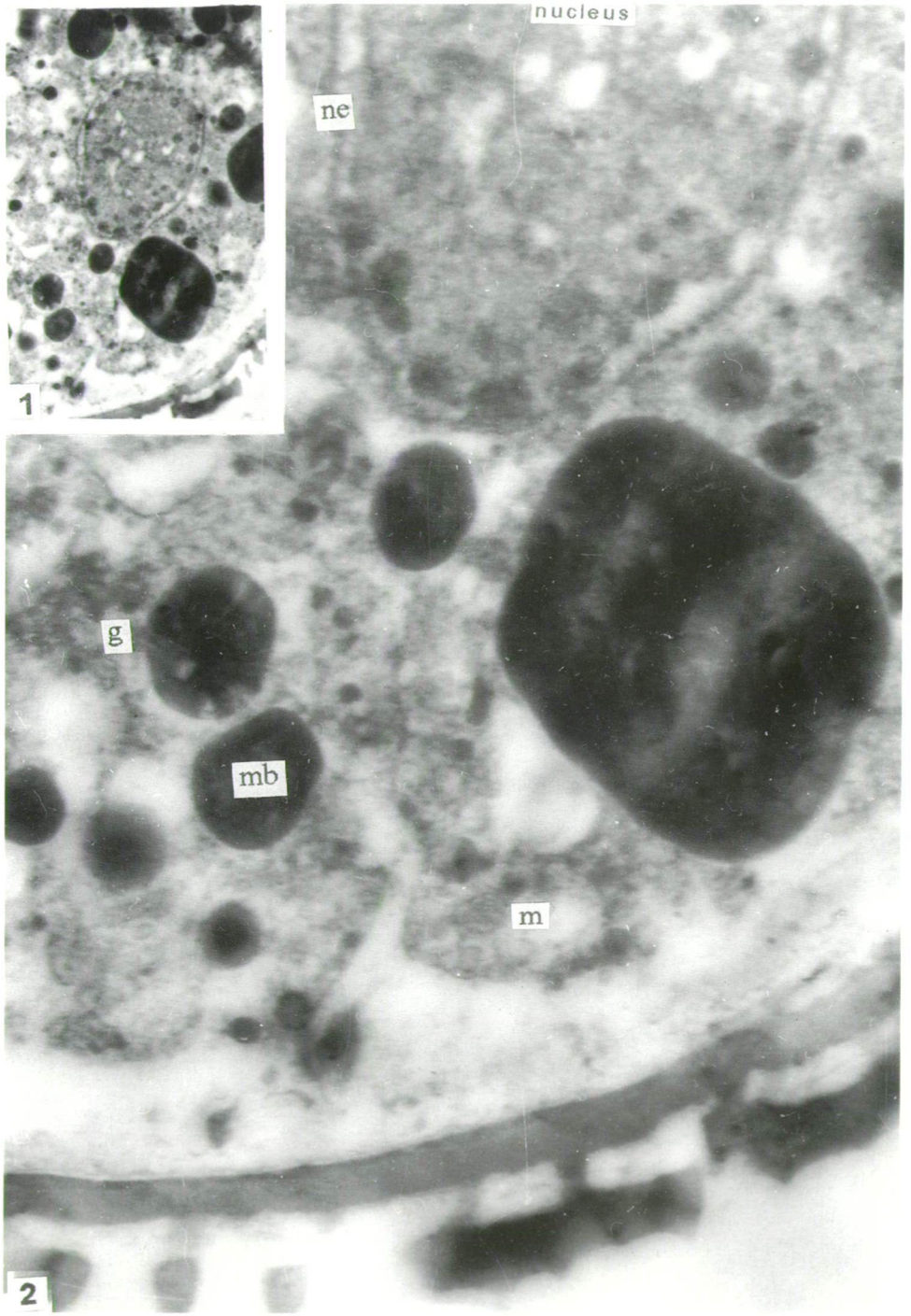

Plate 9.3.

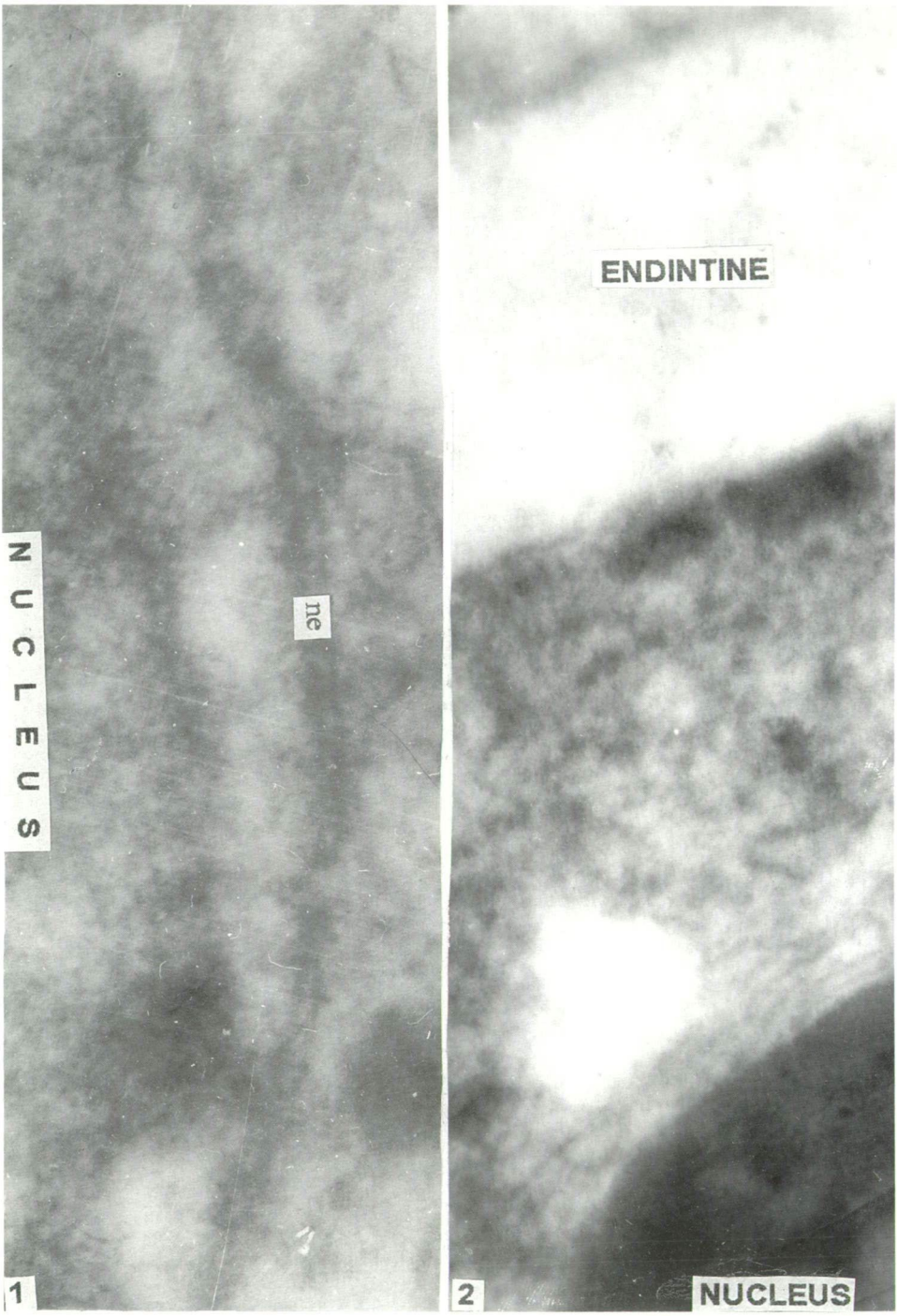

Plate 9.4.

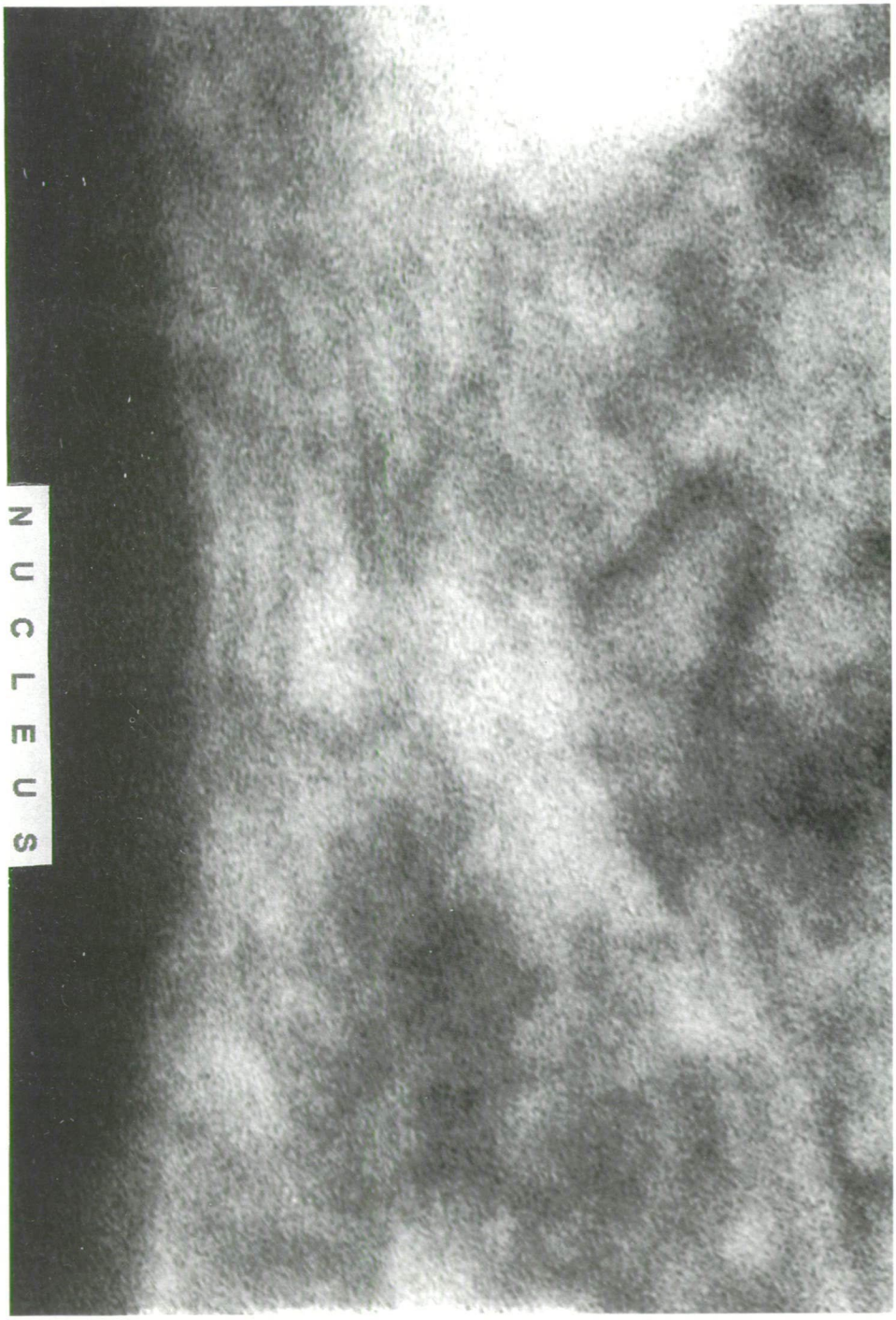

Plate 9.5.

10. COMPUTER MODELLING OF THE QUASI-CRYSTALLOID BIOPOLYMER STRUCTURE IV.

M. KEDVES and L. KEDVES

Cell Biological and Evolutionary Micropoleontological Laboratory of the Department of Botany of the J. A. University, H-6701, P. O. Box 993, Szeged, Hungary

Abstract

This paper deals with the computer modelling of the single filament, and the α-helix composed of pentagon dodecahedrane units. The method is nearly the same as in our previous papers (1995, 1996, 1997), only the modelling of the superficial network together with the superficial points of symmetry was omitted. In particular the different kinds of points of symmetry of the single α-helix seem to be useful in the interpretation of our partially degraded recent and fossil biopolymer systems.

Key words: Plant cell, biopolymer system, computer modelling.

Introduction

Filaments as one of the earliest biological structure were published by PFLUG (1965 a,b) isolated from the Algonkian. Helical Precambrian organic microfossils (*Spirillinema bentori*) from Sinai were described by SHIMRON and HOROWITZ (1972). Filaments are essential components of the cytoskeleton (KOBAYASHI, FUKUDA and SHIBAOKA, 1987). ROWLEY (1967) published fibrils, microtubules and lamellae from the pollen grains. HESLOP-HARRISON, Y. and HESLOP-HARRISON, J. (1982) investigated the microfibrillar components of the intine. Radially oriented chain-molecules were described at the ontogenetically different layers (ectexine and endexine) of the partially dissolved pollen grains of *Pinus griffithii* MCCLELL by KEDVES, TÓTH, KÁROSSY and VARGA (1996). Following MACKAY (1990) α-helix was demonstrated at the structures of the amino-acids by PAULING and COREY (1951). ROWLEY, J. R., DAHL and ROWLEY, J. S. (1980) described first the helical subunits from the exine of *Artemisia* pollen grains. Later ROWLEY, J. R., DAHL, SENGUPTA and ROWLEY, J. S. (1981) published a model for the exine substructure. ROWLEY, J. R., EL-GHAZALY and ROWLEY, J. S. (1987) described the subunits of the microchannels of the pollen exine. Fossil helical biopolymer unit was published from the Jurassic carbonate manganese layers by KEDVES (1987). During the three dimensional modelling of the quasi-crystalloid biopolymer structures (KEDVES 1991, 1992) the filaments and the helical structures were also the subject of our investigations.

It was emphasized previously that to investigate several characters of the quasi-crystalloid biopolymer systems and the stabilizing molecular structures the computer modelling is the unique method. In this way the aim of this contribution is to investigate with this method these two very important structures.

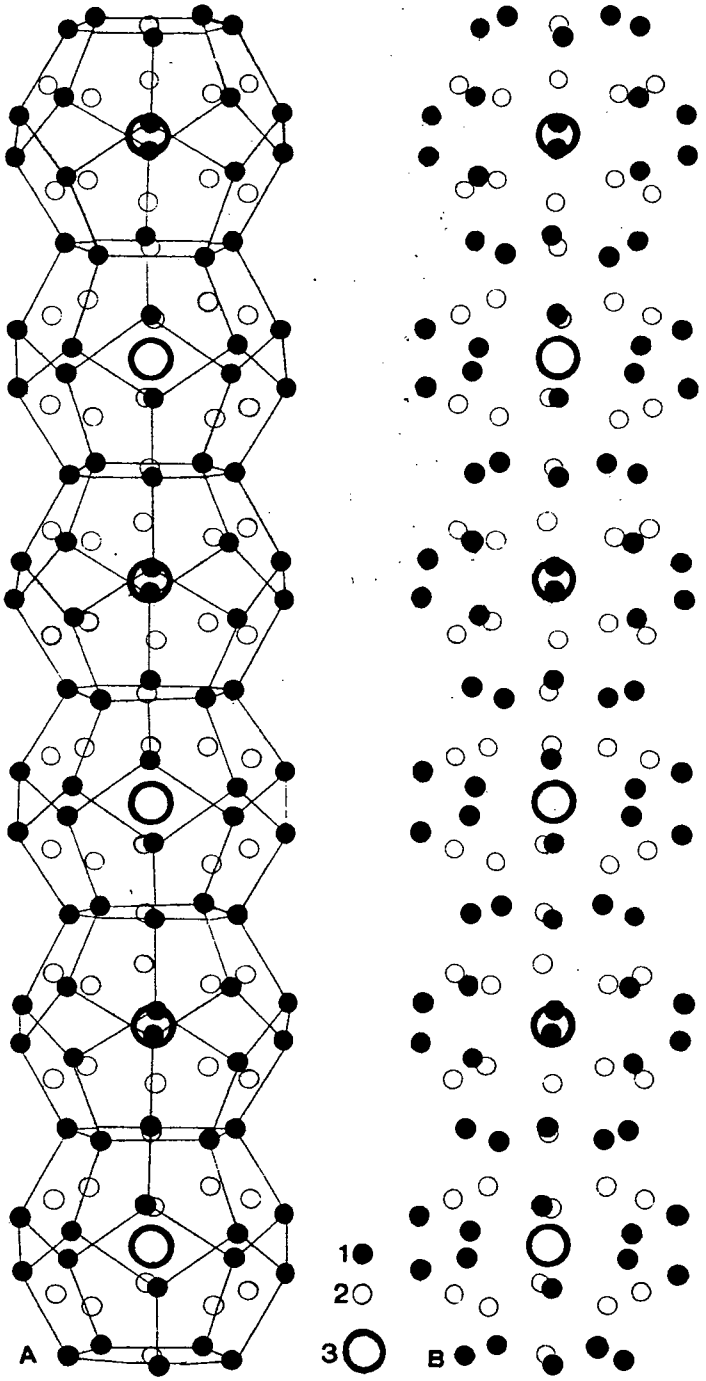

Plate 10.1.

Methods

The basic method was elaborated and described in our previous papers (1994, 1995). The symbols are also the same as in the previous publications. The following characteristic features of symmetry were the subject of this contribution: 1. The network of the quasi-crystalloid skeleton together of the three kinds of points of symmetry. 1.1. The centrum of the pentagon dodecahedrane. 1.2. The points of symmetry of the edges of the pentagonal planes, 1.3. The centrum of the pentagonal planes. 2. The points of symmetry of the quasi-crystalloid biopolymer system without network.

Results

1. FILAMENT (Text-fig. 10.1 A,B)

A so-called single filament was modelled. Text-fig. 10.1A represents the lateral view of the quasi-crystalloid skeleton and all points of symmetry, including the central stabilizing units also. The regular alterning characteristic features of the skeletal network of the pentagon dodecahedrane units and the different kinds of points of symmetry are well shown. Particularly the central stabilizing globular units are interesting. In two dimensions, the schema of each second central stabilizing unit surrounds two points of symmetry of the edges of the quasi-crystalloid skeleton. At the other stabilizing units the two points of symmetry are near the central unit in the axial line of the filament. In lateral view the part of the quasi-crystalloid skeleton around the central stabilizing units is a rhombus form.

The points of symmetry of the single filament without network (Text-fig. 10.1B). The axial points of symmetry represent the following alterations. In the axis there are six nearby points of the edges of the pentagons. At each second "pentagon dodecahedrane unit" two of them are surrounded by the contour of the central stabilizing unit as it was discussed previously. Perpendicular to the axis of the filament two different kinds of patterns of points of symmetry are characteristic which follow the regular alterations of the central points of symmetry.

2. SINGLE α-HELIX (Text-figs. 10.2., 10.3.)

The computer model of this simple helical structure of pentagon dodecahedrane units well demonstrates the complexity of this problem. First of all the arrangements of the different kinds of points of symmetry and the network of the quasi-crystalloid skeleton depend from the orientation of the helical unit. By the different orientation of the single helical structure several different patterns of network, and points of symmetry may be obtained. We have chosen a lateral view, which may be useful in the interpretation of the biopolymer structure of the microchannels also. Text-fig. 10.2. well illustrates the position in the quasi periodic system every skeletal and the central stabilizing biopolymer system of the pentagon dodecahedrane unit. Without quasi-crystalloid network, the results of the pattern of the different kinds of points of symmetry may be summarized as follows:

Text-fig. 10.1.

Computer model of the single filament composed of pentagon dodecahedrane units. Legends: 1. Points of symmetry of the edges of the pentagon dodecahedrane units. 2. The centres of the regular pentagon planes. 3. The centrum of the pentagon dodecahedrane units.

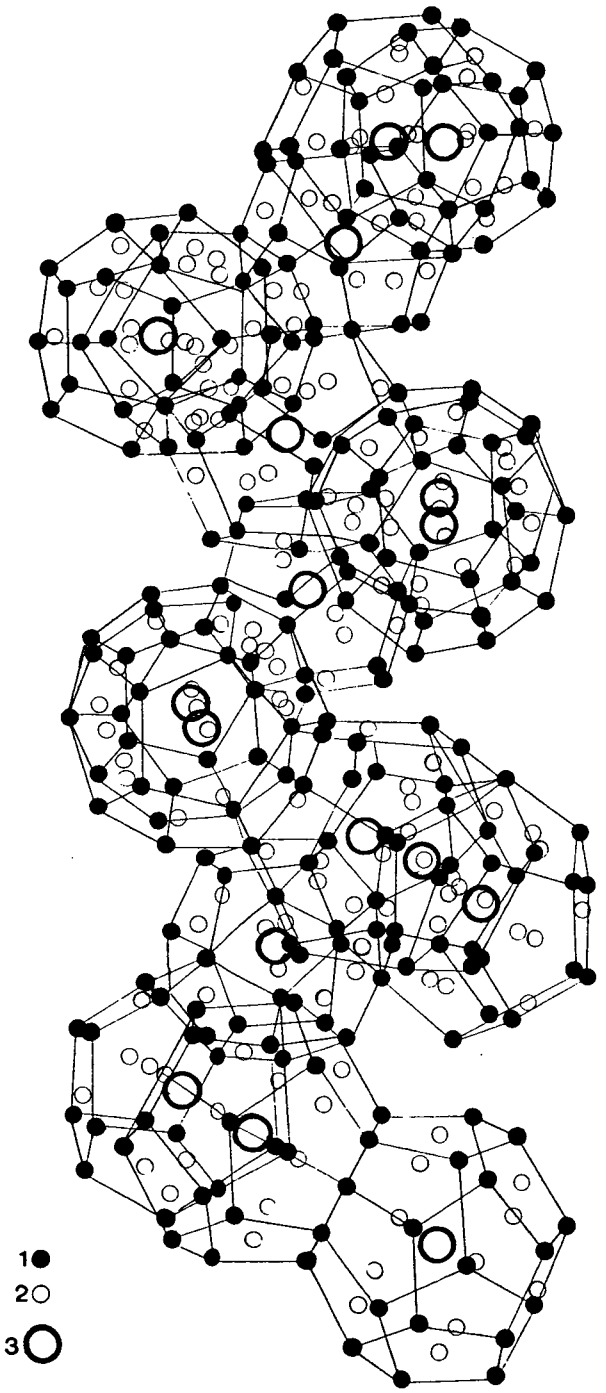

Plate 10.2.

Plate 10.3.

2.1. The schemas of the central stabilizing biopolymer form a zigzag. In two dimension the skeletal biopolymer points of symmetry are arranged in different patterns.

2.2. It seems as the most important the pattern of the points of symmetry of the edges and the centrum of the pentagonal planes. In optimal view may be observed the connections of two pentagonal polygon by five points of the edges, and two times five points of the centrum of the planes. As the other kind of pattern we would like to emphasize the following:

2.2.1. Pairs of points of symmetry.

2.2.2. Threefold groups of points of symmetry.

2.2.3. Linear arrangement, which may be simple or ramified.

2.2.4. Further regular or irregular groups of points of symmetry.

Discussion and Conclusions

1. The quasi-crystalloid skeleton of the single (primary) filament was investigated by the three dimensional modelling (KEDVES, 1992). The alterations of symmetry of the consecutive pentagon dodecahedrane units were analyzed by this method also. To this in the first place the symmetry of the central stabilizing unit and its surrounding skeletal and further points of symmetry modelled by the computer method may be pointed out. To this the computer modelling is the unique method. The pattern of the skeletal points of symmetry is very useful in the interpretation of the TEM pictures of the partially degraded or dissolved cell walls. Particularly after the different kinds of rotations we have observed such arrangements of biopolymer units. To this our newest results may be mentioned (KEDVES, TRIPATHI, VÉR, PÁRDUTZ and ROJIK, 1998, KEDVES and BORBOLA, 1998).

2. The three dimensional model of the quasi-crystalloid skeleton of the single helical or microfibrillar structure was investigated in different aspects previously (KEDVES, 1991, p. 72., plate 7.3.). At this first modelling, the points of symmetry of the edges of the pentagons were only illustrated together with the pentagon dodecahedrane units. At this kind of investigation the complexity of the pattern of points of symmetry depending from the aspect of the investigation was clear. The computer modelling added two kinds of points of symmetry to the previous method. This was the reason that for the first time one aspect was investigated only from the helical unit by the computer method. Here also the points of symmetry of the α-helix without network are very important in the interpretation of our TEM pictures before and after different kinds of rotation. In this way for example linear biopolymer structures may also be present as a part of the helical quasi-crystalloid biopolymer structures.

Finally it is necessary to emphasize that the computer and other modelling and investigations of the biopolymer system of the living and fossil plant cell walls is not yet finished. The helical system by its complexity needs also further investigations.

Text-fig. 10.2.

Computer model of the single α-helix composed of pentagon dodecahedrane units.

Text-fig. 10.3.

Computer model of the single α-helix composed of pentagon dodecahedrane units without network.

Acknowledgements

This work was supported by Grant OTKA 1/7 T 014692.

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11. LIST OF PUBLICATIONS OF THE LABORATORY UNTIL DECEMBER 1998

Compiled by

A. BORBOLA and É. PAPP-NAGY

Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J.A. University, H-6701, P.O. Box 993, Szeged, Hungary

ALVAREZ RAMIS, C., KEDVES, M. y FERNÁNDEZ MARRÓN, T. (1998): Asociaciones esporopolínicas del Cretácio superior del Cerro de la Mesa (Guadalix de la Sierra, Provincia de Madrid). – Bot Macaronésica 23, 191–199.

BORBOLA, A. and ERDŐDI, Á. (1998): Chronicle. - Plant Cell Biology and Development 9, 104-109.

KECSKEMÉTI, V. and RONTÓ, G. (1998): List of publications of the Laboratory until December 1997. - Plant Cell Biology and Development *9*, 103.

KEDVES, M. (1998a): Upper Cretaceous pollen grains from Egypt II. - Plant Cell Biology and Development (Szeged) *9*, 8-27.

KEDVES, M. (1998b): Études palynologiques des couches du Tertiaire inférieur de la Région Parisienne IX. - Plant Cell Biology and Development (Szeged) *9*, 28-42.

KEDVES, M. (1998c): A magyarországi pre-quarter palinológia irányzatai és perspektívái. - 1. Magyar Őslénytani Vándorgyűlés 1998. Május 8-9, Tata, Program, Előadáskivonatok, Kirándulásvezető, 8.

KEDVES, M. (1998d): LM and TEM investigations on Hungarian Neogene lignites. - The 5th European Palaeobotanical and Palynological Conference, June 26-30 Cracow-Poland, Abstracts, 88.

KEDVES, M. (1998e): Importance of the infratectal layer of the pollen grains. - Pollen and Spores 1998 Morphology and Biology. An International Conference. The Royal Botanic Gardens, Kew 6,8 and 9 July 1998 and the Natural History Museum, London 7 July 1998, 35.

KEDVES, M. (1998f): Paleocene palynomorphs from the NW part of the Adriatic Carbonate Platform. - Dela - Opera SAZU 4, 34, 59-63.

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KEDVES, M. and KÁROSSY, Á. (1998): X-ray effect on the LM morphology of some angiosperm pollen grains II. - Plant Cell Biology and Development *9*, 88-92.

KEDVES, M. and PÁRDUTZ, Á. (1998): Ultrastructural study of X-ray irradiated spores of *Equisetum arvense* L. - Taiwania *43*, 193-202.

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Chronicle

compiled by

Erika HORVÁTH

Visiting scientists

Prof. Dr. C. Alvarez RAMIS (Departamento de Paleontologia, Facultad de Ciencias Geológicas, Universidad Complutense de Madrid) , as invited professor of the Geological Section of the Hungarian Academy of Sciences worked in the Laboratory on the joint research programs. Cretaceous and Tertiary sporomorphs are the subjects of these researches. The project of the further researches was also discussed. She arrived on the 12th June and left Szeged on the 17th June.

Prof. Dr. Edward A. STANLEY (Ardmore, PA, U.S.A.) and his wife, Ann STANLEY visited Szeged and the Laboratory from 20th until 23th August. The purpose of the visit was the award of Prof. Dr. E. A. STANLEY with the Commemorative Medal of the Laboratory, but he informed about the experimental investigations of the Laboratory.

International Laboratory activities

27 January–07 February, 1998, Lucknow, Uttar Pradesh, India.
Prof. Dr. M. KEDVES visited again the Birbal Sahni Institute of Palaeobotany. The joint research programs and the first results were discussed with Prof. Dr. Anshu K. SINHA Director of the B.S.P.I. He together with Dr. S.K.M. TRIPATHI and Dr. Madhav KUMAR worked on the manuscript of the first part of the joint research program on the experimental studies of the palm pollen grains of India. During his stay in Lucknow several further research programs were planned.

08–11 February, 1998, New Delhi, India.
During his visit in New Delhi at the Indian National Science Academy Mr. M.S. PELIA Section Officer received Prof. Dr. M. KEDVES, and the results of the research programs of the Birbal Sahni Institute (India) and the Cell Biological and Evolutionary Micropaleontological Laboratory (Hungary) were discussed.

25 June–1 July, 1998, Cracow, Poland.
At the 5th European Palaeobotanical and Palynological Conference, on the 27th June, the following oral communication was presented :
KEDVES, M.: LM and TEM investigations on Hungarian Neogene lignites.

4–10 July,1998, The Royal Botanic Gardens, Kew, London, United Kingdom.
M. KEDVES presented a poster ("Importance of the infratectal layer of the pollen grains"), at the International Conference; Pollen and Spores 1998 Morphology and Biology, on the 8th July.

26–28 September, 1998, Madrid, Spain.

Prof. Dr. C. ALVAREZ RAMIS and Prof. Dr. M. KEDVES discussed the up-to-date problems of their scientific cooperation.

29 September–3 October, 1998, León, Spain.

At the XII Simposio de Palinologia APLE, on the 1st October the following oral communication was presented:

KEDVES, M., BORBOLA, A., HORVÁTH, E. and TÓTH, A.: Sur les problèmes de la Palynologie expérimentale.

Hungarian scientific activities

On the 15th January appeared the 9th number of Plant Cell Biology and Development.

At the 1334th meeting of the Botanical Section of the Hungarian Biological Society on the 6th April, the following lecture was delivered by M. KEDVES:

„Zárvatermő pollenszemek evolúciója és ősnövényföldrajza a felsőkréta időszakban" (Evolution and paleophytogeography of the *angiosperm* pollen grains during the Upper Cretaceous).

On the 7th April, at the meeting of the Geological Section of the Hungarian Academy of Sciences Prof. Dr. M. KEDVES presented the following paper: „Fosszilis spórák és pollenszemek ultrastruktúrája" (Ultrastructure of the fossil spores and pollen grains).

At the 1st Hungarian Paleontological Symposium (8-9, May, Tata, Hungary) the following oral communication was presented on the 8th May by M. KEDVES: „A magyarországi pre-quarter palinológia irányzatai és perspektívái" (Trends and prospects of the Hungarian pre-Quaternary Palynology).

On 24th August at the Conference of Symmetry and Asymmetry (Szeged, Hungary), M. KEDVES delivered the following communication: „A zárvatermő pollen evolúció és paleofitogeográfia szimmetria kérdései" (The symmetry problems of the evolution and paleophytogeography of the *angiosperm* pollen grains).

At the meeting of the Paleontological Commission of the Hungarian Academy of Sciences (Budapest) on the 17th September the following communication was delivered by M. KEDVES: "Felsőkréta kori zárvatermők származása és elterjedése a palinológiai eredmények alapján" (Origin and distribution of the Upper Cretaceous angiosperms on palynological basis).

30 November 1998, Budapest (1341th meeting of the Botanical Section of the Hungarian Biological Society), M. KEDVES presented his paper:

„A kísérletes palinológia újabb transzmissziós elektronmikroszkópos eredményei" (Newest TEM results of experimental Palynology).

Plate I.

1. Prof. Dr. Edward A. STANLEY, Prof. Dr. M. KEDVES and Ann STANLEY (from left to right) in the Laboratory.

2. Group of the participants at the reception of the Laboratory. From left to right: E. HORVÁTH, Prof. Dr. Edward A. STANLEY, Dr. A. TÓTH, Ann STANLEY, Dr. G. JUEZ, Prof. Dr. M. KEDVES, and A. BORBOLA. The pictures were taken by Dr. É. SIPOS-KEDVES.

1

2

Plate 1.

20.02.1998

Report on the results of the visit in Lucknow, India, by: M. KEDVES.

The contribution of the Laboratory at international scientific meetings of this year, speaker: M. Kedves.

The state of the number 1999 of Plant Cell Biology and Development.

28.03.1998.

The contribution of the Laboratory in international scientific research programs, speaker: M. KEDVES.

Other businesses, speaker: M. KEDVES.

25.04.1998.

Publications of the Laboratory in international reviews, speaker: M. KEDVES.

Duties of the Laboratory for the contribution at international scientific meetings, speaker: M. KEDVES.

Preparations of the jubilee volume of Plant Cell Biology and Development, and presentation of the laboratory medals of 2000, by M. KEDVES.

Decision on the persons to be awarded with the Commemorative Medal of the Laboratory, 1998.

13.06.1998.

The following new middle school students became their scientific working at the Laboratory: BORSODI, A., DOBÓ, K., HORVÁTH, A., HORVÁTH, ESZTER, KANCSÁR, T., KOVÁCS, T., SZÉCSÉNYI, A. and TERBE, Zs.

21.08.1998.

On the occasion of the 8th Anniversary of the Laboratory the following persons participated at the exclusive reception: Professor Edward A. STANLEY, his wife, Ann STANLEY, (U.S.A.), Dr. Gabriela JUEZ (Chile), BORBOLA, A., HORVÁTH, E. and Dr. TÓTH, A.

Prof. Dr. M. KEDVES presented the awarded persons of this year:

Prof. Dr. Eszter NAGY (Budapest, Hungary) for her important results on the Neogene palynology in Hungary, and for her sacrificing efforts for the Palynology in the Hungarian scientific life. Regrettably she couldn't participate at this meeting because of the illness of her husband.

Prof. Dr. W.E. EL-SAADAWI (Cairo, Egypt) for the contribution of the joint researches on the Cretaceous Palaeobotany in Sinai. He couldn't visited Laboratory at this occasion in consequence of financial problems.

Prof. Dr. Edward A. STANLEY for his very important results on Cretaceous palynology, in particular in the Aquilapollenites Region in the U.S. and for several joint research programs within the international scientific programs of the N.S.F. and the K.K.I. Within this program combined studies were made on North American and European *Normapolles* and *Postnormapolles* taxa, LM, SEM and TEM methods were used. The enlarged SEM pictures taken in the EM Laboratory of the Georgia State University decorated the wall of the Laboratory (Picture 1, Plate 1.)

Plate 2.

1,2. Both sides of the silver medal of the "2000 Outstanding People of the 20th Century" The pictures were taken by Dr. I. BAGI.

2000
Outstanding People
of the 20th Century

INTERNATIONAL BIOGRAPHICAL CENTRE
CAMBRIDGE ENGLAND

Plate 2.

19.08.1998.

Report on international scientific meetings, (Cracow, Kew), speaker: M. KEDVES.

Participation at the international scientific meetings and research programs, speaker: M. KEDVES.

The present day state of numbers 10 and 11 of Plant Cell Biology and Development, speaker: M. KEDVES.

10.10.1998.

Report on the XII APLE symposium (León), speaker: M. KEDVES.

Commemoration to Dr. B. ZÓLYOMI, member of the Hungarian Academy of Sciences. M. KEDVES reviewed the scientific work of B. ZÓLYOMI in particular his palynological achievements which were appreciated worldwide. His scientific activity may be characterized by multidisciplinarity, centered on ecology and vegetation history was. His effort for the recognition of Hungarian palynology was also extremely important for the maturing generation in this field of researchers. He worked until the last minute of his life, he was really a great scientist and man.

The newest experiments of the Laboratory for 1999. The hydratation effect, the biopolymer symmetry and the new methods for the partial destruction of the sporopollenin of the recent and fossil sporomorphs.

07.11.1998.

Malvaceae pollenszemek kísérletes vizsgálata (Experimental studies of *Malvaceae* pollen grains), speaker: E. HORVÁTH.

The up-to-date problems of the Laboratory, speaker: M. KEDVES.

Teaching program of the Laboratory.

During 1998 the following lectures were delivered:

1. Applied Palynology; 2 hours weekly.
2. Biopolymer organization and symmetry, 1+2 hours weekly.
3. Theory of Evolution and Natural Philosophy, 1 hour weekly.
4. Quasi-crystalloid biopolymer systems, 1+2 hours weekly.
5. Basic Palynology, 1+2 hours weekly.
6. Theory of the Supernova, 1 hour weekly.

Awards

During this year Prof. Dr. M. KEDVES was awarded with the silver medal of the "2000 Outstanding People of the 20th Century" (Plate 2., figs. 1,2). Donator: International Biographical Center, Cambridge, England.

The biography of Prof. Dr. M. KEDVES was published in the 15th Edition of "Who's Who in the World".

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